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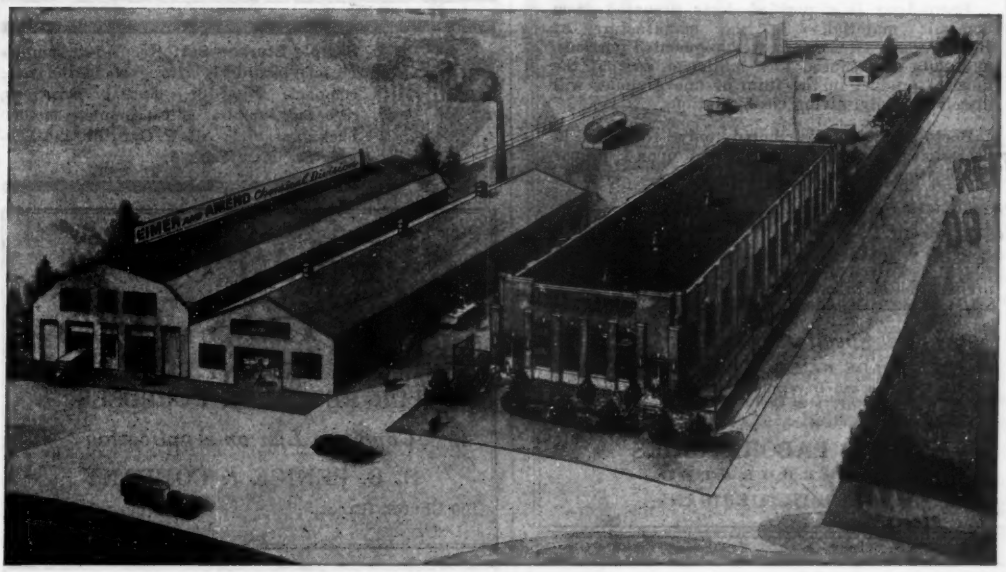

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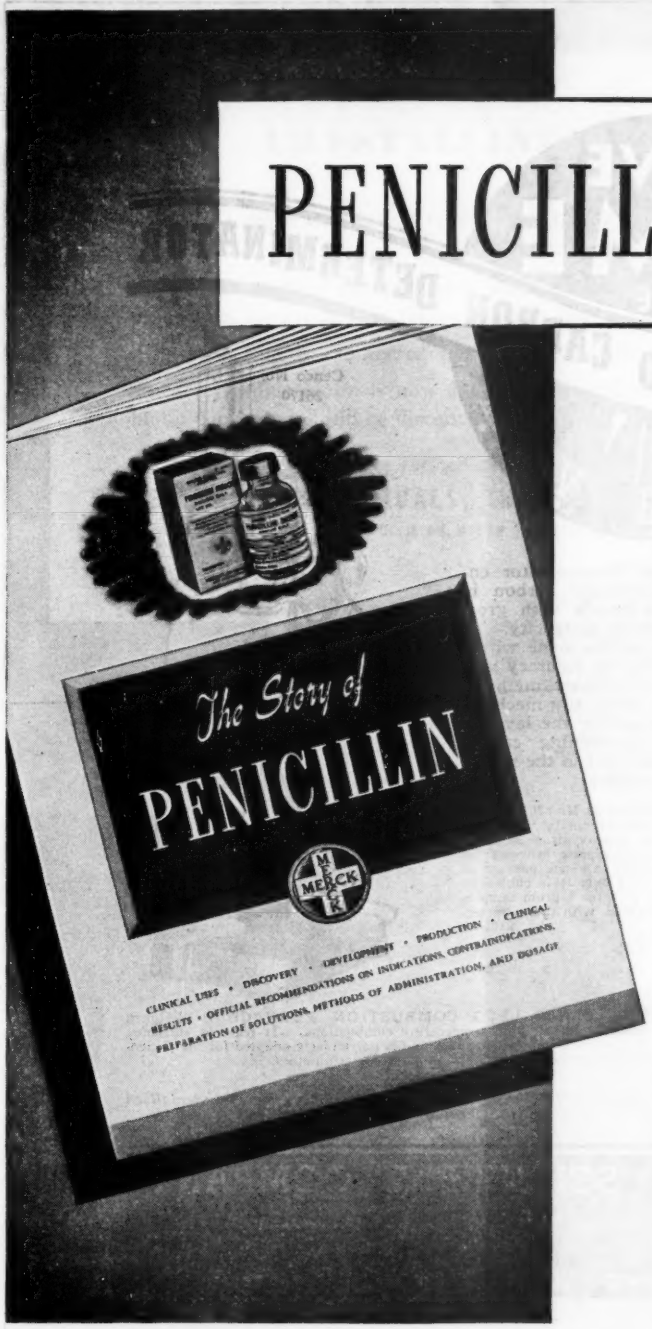
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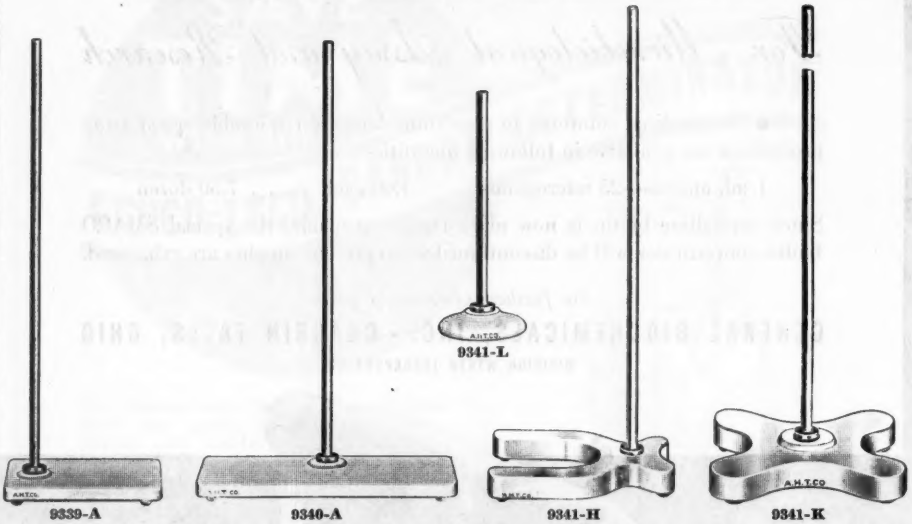

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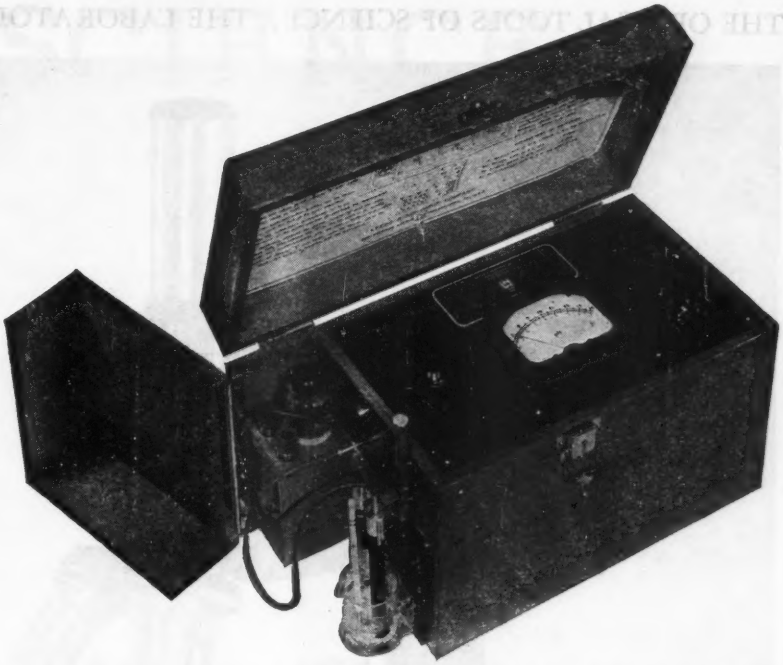

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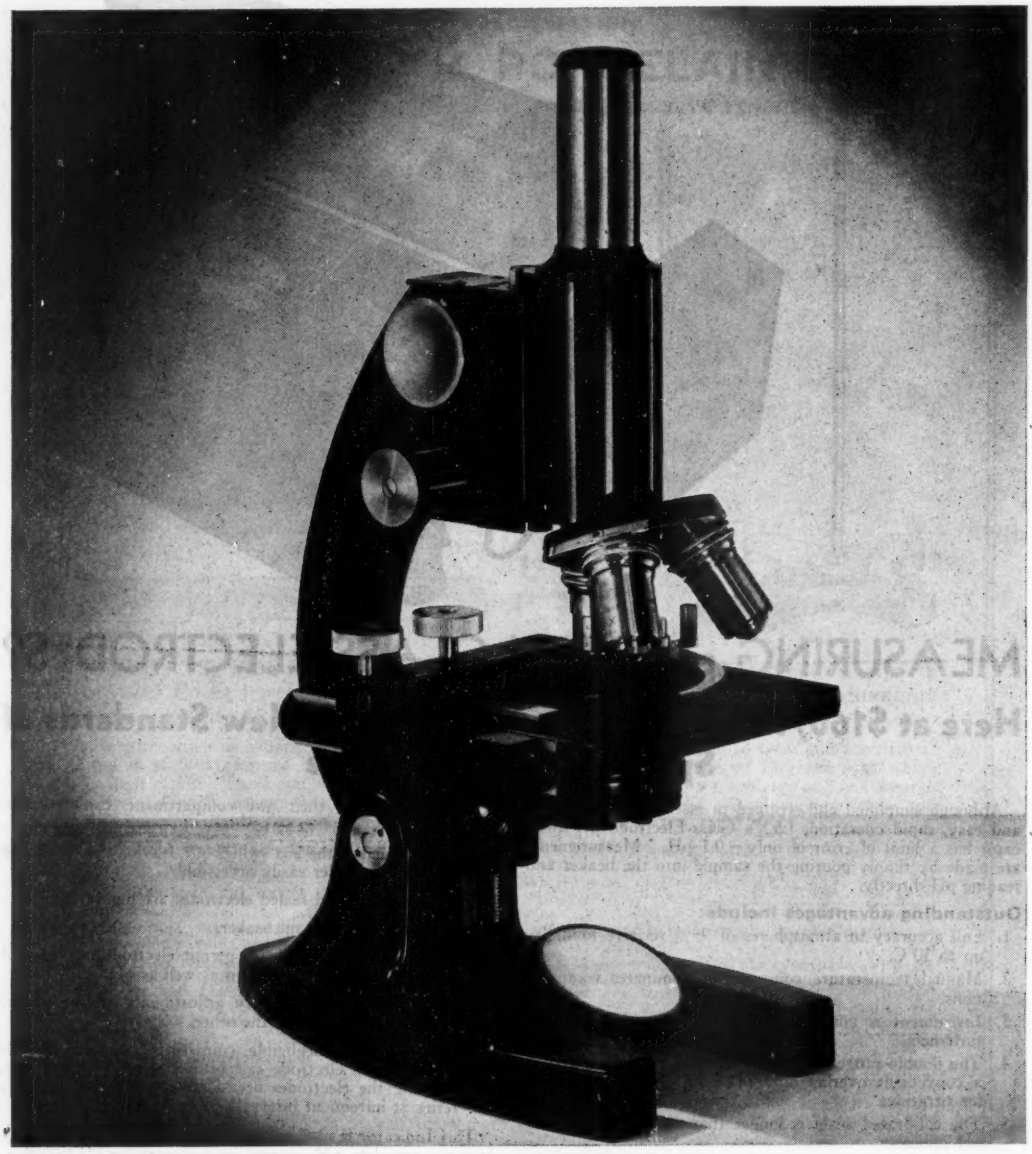

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VITAMINS IN OUR FOOD[1]

By Professor A. E. MURNEEK

UNIVERSITY OF MISSOURI

MY appearance on this program, I wish to assure you, is not of my choice. I am the object of a well-established punishment to those who have been "honored" due to previous servitude and an annual or perennial display of the older folks for the amusement or encouragement of the younger generation.

The particular subject, however, is of my selection in order to fit into the general program of "Nutrition —Some Current Views." Vitamins must have gained an alarming popularity, when a non-specialist, like myself, desires to discuss them before a group of assorted specialists. Plants and vitamins, however, are so closely linked that, as a horticulturist and plant physiologist, I, too, have been obliged to deal with them more intimately—the "little things" in nutrition that now count so much. If in this discussion I may be unduly critical, kindly forgive me by ascribing it to no greater fault than that due to emotional simplification, personal prejudice or perchance conservatism come with age. In agreement with Thorstein Veblen, I do not wish to criticize but merely to understand. If disparagement is involved in this quest for certainty, I hope for your graciousness.

[1] Address of the retiring vice-president and chairman of Section O (Agriculture), read before the joint meeting of Sections O and G (Botany) of the American Association for the Advancement of Science, Cleveland, Ohio, September 14, 1944.

DEMONSTRATION AND DISTRIBUTION OF VITAMINS

According to an older definition, a vitamin is a catalytic substance indispensable in animal or human nutrition. It can not be synthesized in their organisms but must be obtained from plants. Now we know that all plants, likewise, require certain vitamins and that many of them are heterotrophic, must obtain their vitamins from an external source. This certainly is

true of most cryptogams. In this metabolic relationship to the higher plants, fungi and bacteria show a striking similarity to animals. A most recent authoritative definition of a food factor of vitamin nature would be then something like this: "An organic substance, the need for which results from the loss of the capacity for its synthesis, whose action is catalytic, quantitative and markedly specific."[2] This excludes the many inorganic biocatalysts such as Fe, Cu, Mn, Zn, Mo, etc., the action of which is quite similar.

It is interesting indeed to speculate why and how this loss has occurred in the evolution of many organisms and whether it could be sometimes regained. It is assumed that the capacity for synthesis in plants and animals of all required substances degenerated during very early stages of evolution. From this complete biochemical independence have evolved, probably through mutations, changes of an adaptive or symbiotic character, leading organisms and organs to heterotrophism, saprophytism or parasitism. We are inclined to believe that this is a kind of economy in organic life and not merely variability. Some think that the general autotrophism of the green plants shows a tendency to decline, as is testified by the disappearance of certain substances in the higher phyla.

Of the numerous vitamins discovered so far almost all are found in the higher plants, though some are synthesized by animal cells also. Their exact and varied functions are still to be disclosed, though the present evidence points to a close connection with the activity of enzymes. They may have, however, many other biochemical roles in the organism.[3] As regulators of metabolism, these organic catalysts may serve in the chemical relation of tissues and organs of a plant or animal.

While a partial heterotrophism may exist in certain organs of green plants, requiring an external supply of particular vitamins, many of the lower plants are completely heterotrophic for one or several of these growth factors. For their best development specific vitamins have to be given in the culture medium. Certain fungi (*Phycomyces, Mucor, Ustilago, Phytium,* etc.), yeasts (*Saccharomyces*) and bacteria (*Rhizobium, Staphylococcus, B. lactis acidi,* etc.), therefore, are widely used to demonstrate the presence or necessity of vitamins in plant and animal nutrition.

Because of the relatively limited nutrient and general environmental requirements in their culture, microorganisms are now utilized extensively also for the study of biosynthesis of particular growth substances. Other avenues of approach (root, embryo and tissue cultures) have also been explored for this purpose. A very complete summary of the whole subject of relationship of vitamins to plants has been recently prepared by Schopfer (*loc. cit.*).

Though formerly particular organs or tissues of plants and animals were the chief source of vitamins, now, as a result of the establishment of their identity and structure, many of them are synthesized *in vitro* and available on the market under appropriate chemical names. Eventually others will come, in their pristine purity, from the laboratory and the factory.

Vitamins in Human Nutrition

Our first ideas about and interest in vitamins began with man and are of greatest importance at present in relation to human nutrition. The recognition and necessity of these accessory substances in our food are based on the commonly observed fact that when a "purified diet" is supplied avitaminosis (vitamin deficiency) symptoms set in, which can be removed by adding to the food the appropriate vitamin either in a crude or refined state. Small animals are conveniently used for the demonstration and assay of necessary accessory food substances.

As a result of a one-sided diet, particularly of processed foods, vitamin deficiency symptoms have been observed repeatedly in humans, though deaths from this cause are not so common, as judged from mortality statistics in the United States. Current appraisals of the nutritional states, especially those made by H. K. Stiebeling and associates,[4] based on dietary surveys in this country and Canada, show that the prevalence of malnutrition, due to vitamin shortage, is quite high, if pre-clinical methods of recognition are employed.[5] It has been reiterated by political and sociological authorities that one third of our population is "ill fed" and that better nutrition should be a major national policy.

As a result of such activity, and vitamin assays of foods commonly used by large groups of people, recommended dietary allowances or norms, as to optimal vitamin requirements, have been established by the Food and Nutrition Board of the National Research Council, some federal and other agencies. Certainly we have become extremely vitamin conscious, when judged by the interest displayed. Some believe that the evidence does not justify this alarm, that our diets are not impairing our health to the extent many nutritionists would have us believe, and that vitamins have become highly emotional words.[6] We do not know as yet to what extent the intestinal flora syn-

[2] "Plants and Vitamins." W. H. Schopfer, Chronica Botanica Co., Waltham, Mass., 1943.

[3] H. H. Mitchell, "The Chemical and Physiological Relationship Between Vitamins and Amino Acids," in "Vitamins and Hormones," Vol. 1. Academic Press, N. Y., 1943.

[4] H. K. Stiebeling *et al.*, U. S. Department of Agriculture Circular 507, 1939, and *Misc. Bulletin,* 405, 1941.

[5] N. Joliffe and R. M. Most, "The Appraisal of Nutritional States," in "Vitamins and Hormones," Vol. I. Academic Press, N. Y., 1943.

[6] L. Clendening, *Jour. Am. Med. Asn.,* 117: 1035, 1941.

thesizes many vitamins, some of them conceivably in quantities sufficient to support a normal nutritional state.[7] Neither are we certain of the capacity for storage and economy of the human body for these nutritional factors.[8] Moreover, some vitamins may have a sparing action on others.[9] The rat, on which many food assays are being made in the laboratory, is thought by some to be an unsatisfactory animal for this purpose because of its scavenger habits. This animal may be far more heterotrophic for many accessory food substances than man is. But above all, it has been pointed out that the relationship between health, vitamin deficiency syndromes and vitamin content of foods and diets has not been determined carefully enough for a basis of definite recommendations or strict rules in human nutrition.

VITAMIN CONTENT OF FOODS

Great diligence having been displayed in vitamin assays of the major foods used in human diets, an impressive array of data is extant on the content of these substances in many raw and prepared products.[10] One has the feeling that such records have accumulated faster than it has been possible to digest them. The information, however, seems to point to the general facts that foods of the same kind vary greatly as to their vitamin values and that several factors contribute to this variation: (a) There is a natural inherent (genetic) variability in this, as in many other respects, among species, varieties and strains of food-producing plants and animals. (b) The time of harvesting or slaughter and the methods of transportation and marketing of food materials is of great importance.[11] (c) Processing or refining in the manufacture of our modern foods, above all, has frequently played havoc with many vitamins, though it has made such products more appealing and convenient otherwise. I shall attempt to discuss in somewhat greater detail this situation in our food supply, using fruits and vegetables as examples.

Varietal differences in vitamin content: In our search for desirable varieties of food plants, attention has not always been paid to quality of the crops they produce and, till lately, not at all to the vitamin content. Size, appearance, carrying or storage properties, together with yield and regional adaptability, have commonly played the major role in varietal selection of fruits and vegetables. Many choice varieties and strains, formerly grown in our gardens and orchards or for local trade, have disappeared or become of minor importance, because the product was not of a desirable appearance or too tender for distant transportation or prolonged storage. One may search in vain on most markets to-day for a carrot that tastes like a carrot, sweet corn as delicious as the old Golden Bantam, lettuce that is less crisp but has more flavor, plums spicy like those of the Gage or Americana types, apples sweet and delicious like some of the old yellow and russet varieties. This is not a nostalgic longing for the "good old days," but a mere statement of facts and in full awareness that many varieties of food plants have been improved lately. By catering to the "eye-appeal" we have, in our choice, often lost "food value," including undoubtedly a large amount of vitamins, both known and unknown. Thus economics and style, not nutrition and health, unfortunately have guided most parties concerned in food production and distribution.

Realizing the present situation, many plant breeders are engaged now in improvement of the food plants in the direction of higher vitamin content and other properties that make them more valuable for human consumption.[12] In this activity to obtain more nutritious varieties, wild plants may play an important role as breeding materials. Frequently they are much higher in vitamin content than cultivated ones and may be of value also because of disease resistance and other desirable characteristics.

Present evidence points to the fact that climate to some extent affects the vitamin content of plants grown for food, but, surprisingly enough, soil fertility seems to be of minor importance in this respect.[13] Effects of nitrogenous fertilizers on ascorbic acid (Vitamin C) formation has been observed in some fruits and vegetables, but this may be associated with the relative yields, the amount of foliage and extent of shading of the fruit. Light seems to have an important function in the formation of Vitamins C and A (carotene) and possibly others. Very little is known as yet on the effects of temperature. In general, however, the genetic constitution of the plant apparently is of far greater importance than the environment, both adaphic and aerial, in which the plant is grown as regards vitamin production.

Effects of modern distribution and marketing on nutritive value of foods: Commercial production of fruits and vegetables is confined at present largely to regions of most favorable soil and climate. These are often distant from many city markets, requiring lengthy transportation and complex marketing for the

[7] A. G. Hogan, *Mo. Agr. Exp. Sta. Bul.*, 446, 1942.
[8] C. A. Elvehjem, *Jour. Am. Diet. Asn.*, 19: 743, 1943.
[9] K. C. D. Hickman *et al.*, *Jour. Biol. Chem.*, 152: 321, 1944.
[10] L. E. Booher *et al.*, U. S. Department of Agriculture Circular 638, 1942. Also, "Tables of Food Composition." Committee on Food Composition, National Research Council, 1944.
[11] G. Adams and S. L. Smith, U. S. Department of Agriculture Misc. Publication, 536, 1944.
[12] R. J. Garber, "Plant Breeding in Relation to Human Nutrition," 1944 (unpublished paper).
[13] L. A. Maynard and K. C. Beeson, *Nutr. Abstr. and Rev.*, 16: 155, 1943.

transfer of the products to consumers. If sold in the fresh state, this frequently necessitates harvesting the crop in an immature condition, thus lowering the food value, including vitamin content. Growers and dealers are fully aware of the situation but find it difficult to remedy. Peaches, cantaloupes, plums, strawberries and many other fruits are often harvested in so "green" a state that a very low quality is realized no matter how they are subsequently handled. This has been so disturbing a factor in marketing that stringent maturity regulations have been promulgated and are enforced in states where fresh produce is grown extensively.

Speedier transportation and better refrigeration to certain extent may overcome this difficulty. It is highly probable that air transportation of fresh produce, which is surely coming, will bring us fruits and vegetables from distant regions in immeasurably better eating quality and of higher vitamin value. Very probably then we shall see the return to favor of some of the choicer tender varieties. Let us hope so anyway. Many "victory gardeners" undoubtedly have at least an inkling now how delicious and healthy peas, sweet corn, tomatoes and many other vegetables and some fruits can be when harvested at the peak of perfection and consumed immediately. There is ample evidence that the vitamin content decreases on delay in the use of fresh produce.

Vitamins in processed foods: Commercial processing of food and living in the modern city have advanced hand in hand. By and large it is nothing more than a factory scale extension of food preservation in the home, which of course has declined greatly. There are certain aspects to this method of food preparation, both good and bad, that have a profound bearing on human nutrition. Buying conserved or prepared foods is usually economical, more convenient and often absolutely necessary for the average housekeeper in a modern city. A large-scale establishment can preserve food by drying, smoking, canning or freezing at infinitely less cost than one may do it individually in one's household. Unfortunately, because of competition or desire for more profit, as a result of what Lin Yutang calls a "swine-and-slop" economics of the avaricious, foods are often prepared hastily and improperly, resulting in a loss of their nutritive qualities. Often enough they are so "denaturalized" of vitamins and other food factors that their use in volume or continuously has resulted in malnutrition and impaired health. Many food processors undoubtedly look with envy at sugar refiners, who have managed to attain the ultimate in food refining. Said E. E. Slosson: "Common sugar is an almost ideal food—cheap, clean, white, portable, imperishable, unadulterable, germ free, highly nutritious, completely soluble, altogether digestible, requires no cooking and leaves no residue. Its only fault is its perfection. It is so pure that man can not live on it." Sugar consumption has increased in the United States from about 9 to 100 pounds per capita during the past hundred years. The total production of this, most voluminous pure organic compound, was over 13 billion pounds in 1939.

In practically all grocery stores there are at present a bewildering array of ultra-modern food preparations. The spongy "starch paste" that is commonly sold as bread, the sweet "goo" that goes into the making of some cereals and many bakery goods, the artificial cheese and other mixtures, synthetic sweets and beverages and many other products are well known to every one. Federal laws do require the listing of ingredients making up such preparations, but the relative quantities of each invariably are not given. And, after all, very few purchasers read this information usually given in small print. One can not help admiring the ingenuity used in preparation of processed foods, the beauty of their appearance, the convenience of their merchandising and the artistry and psychology with which they are presented to the buyer. Manufacturers and dealers study not only consumer demand for certain types of products but sales possibilities and resistance to their most profitable preparations. Modern advertising and mass production of prepared foods have run on parallel tracks.

Some processed foods are so refined that hundreds of thousands of people would develop scurvy and other deficiency diseases were they not eating also many natural "protective foods," especially fruits, vegetables and dairy products. Selected largely by instinct, they compensate for vitamin shortages in other foods. Tomatoes, citrus fruits and the green leaf vegetables are considered by nutritionists of particular value for this purpose and their increased use is being advocated widely.

As a result of the present food situation, a program of fortification or enrichment of flour, bread and a few other cereal food materials and products has been inaugurated. Being to some extent alarmed, and finding it not too inconvenient, the industries have cooperated rather well in this partial restoration of the vitamin content at least of the "staff of life"—bread. Moreover, a Nutritional Foundation has been established to aid the food industry, through research, in solving its problems as related to nutrition and public health and to do this by "lawful and effective means."

VITAMIN PILLS

No sooner was it found that much of our food and some diets are short of the optimal vitamin content

and that many pure vitamins can be bought wholesale at a reasonable price, vitamin pills and tablets appeared on the market and became popular almost overnight. Recently the supply and demand for them has increased tremendously. In some cities there are even special "vitamin shops" or "bars." The vitamin fad has become an epidemic. While most people have only a vague idea what vitamins are, excepting that they are connected with the alphabet, still that does not prevent them from becoming enthusiasts, even faddists. Says H. L. Kretschmer, president of the American Medical Association, according to press reports: "The people of the United States are spending a quarter of a billion dollars annually on vitamin pills and tablets. This means that every morning hundreds of thousands of potent little pellets travel eagerly down as many anxious esophagi into the systems of people, most of whom do not need them." Evidently it keeps them happy.

Vitamin advertisements have increased by leaps and bounds, have gone on the air in volume, invading our ears almost every hour day and night. They have reached even the war front. In a relatively recent dispatch from the Italian Front, Ernie Pyle, popular reporter of the daily press, says: "One night a colonel was talking offhandedly about the war, and how people felt and everything and he said—'The whole trouble with everything is vitamins. We got along all right before everybody had to have so many vitamins a day.'"

The Instinct for Good Food

In animals as well as man nutritional needs seem to have been, and we trust still are, determined largely by instinct. Selection of the proper food has been chiefly by trial and error. Establishment of traditional diets was based on experience and natural taste. With food limited as to variety, the older simpler civilization produced people of splendid physical development. Although an infinitely greater variety of foods is available now, the nutritional condition and stamina of the American people do not seem so good. In less industrialized countries even to-day members of many communities, particularly rural, have certain traditional food combinations or habits. Though they may appear sometimes strange and unreasonable, a mere habit, to the unfamiliar, critical examination almost invariably has disclosed that they were based on fairly sound judgment and often scientifically correct. Facts could be marshalled from observations in many countries, especially among groups of people living on restricted varieties of foods. Before advocating a change in their dietary habits strict attention should be paid to the usually wise composition in vogue.

In a country of a high technical culture, such as ours, old traditional food materials are largely gone. Moreover, new unhealthy habits have been imposed upon many people. Milled grain products, for example, were formerly so prepared that most of the vitamins were retained. Now, because of extreme refining, they have contributed to poor nutrition among large numbers of people, who still cling to traditional habits, using the new refined product in the old way in their diet. Not knowing what has really happened to their flour, meal or grits, they are bewildered and in trouble. The same situation often exists as regards changes in other foods, significantly so in the making of which formerly prolonged fermentation or ageing was an essential step in their preparation. Yeast certainly has the capacity to produce a host of known and unknown dietary factors of vitamin nature.

There is an unjustifiable hope of a simple solution of our nutritional difficulties by an over-emphasis on the value of vitamins, which, under the present circumstances, after all are only a "first aid" and not a fundamental solution of the problem.

Nutritionists, particularly the home economics group, have been paying a great deal of attention lately to the effects of food preparation, mainly cooking, on vitamin retention. It has been reiterated that the housewife or cook, if not on guard, can peel away, soak away, drain away and cook away 50 per cent. or more of the original vitamin content of the food material. Emphasis is placed on the fact that the longer the cooking the more vitamins may be lost. Very little water is to be used in cooking vegetables and fruits, for example, and none discarded.

To get a full dose of vitamins it looks very much as if we will have to eat most of our garden products raw. For all we know the time may eventually come when hubby will be tethered in the vegetable patch to forage his supper of high vitamin and mineral content there. Not all hope for a continuous use of the kitchen stove and the dining room table has faded, however. It is said (L. Clendening) that the fine food in New Orleans, for instance, is due to the fact that it is cooked and often recooked several times. A French chef is supposed to start boiling his Sunday soup on Friday. New Orleans may be making the last stand against vitamins, for preparation of a meal there seems to be based on taste, not on the recognition of the presence of accessory food factors. Vitamins evidently avoid New Orleans and other places where very good well-prepared food is still obtainable, for if they show up, they will be cooked to death. One wonders how people survive and are even healthy on such meals.

Conclusion

Now that "hollow hunger" has been largely eliminated in countries of modern technical culture, we are preoccupied with "hidden hunger." In the search for

its causes, deficiencies in vitamins and minerals in our foods have so far been ascertained as the chief reasons. A large number of vitamins necessary or of value in the human diet have been found. Their list runs through the full length of our alphabet if the fractional parts of those letters that the nutritionists have been obliged to "split" are taken into consideration. Improper selection of food-producing plants, modern methods of handling the crop and faulty preparation by cooking and other means has resulted in a diet of subnormal vitamin content for many people. Refining and processing of foods has devitaminized still further our modern products. Profit has been often the motivating force in present food technology, the dollar sign the guiding star, setting styles, fostering sales and creating eating "habits" for the use, in volume, of certain products.

Having become conscious of the present undesirable food situation, the factors involved are being studied diligently by nutritionists, chemists, plant breeders and food processors. Counter measures are being advocated and promulgated for the breeding of plants of higher vitamin content, for better handling and storage of food materials and for the enrichment or restoration of devitalized food products. The popularity of vitamin pills has reached an epidemic stage, sales being fostered through modern ads wildly by dealers.

In this excitement the scientists hope to create or at least wait for sanity in the attitude of the average man and emotional nutritionists towards vitamins. The instinct for a healthy diet has not been destroyed in most people, though social and economic forces undoubtedly have modified it. We trust that in the future the "common man" will be nourished more properly to the benefit of his gastro-intestinal flora, his health and serenity of his mind. In the meanwhile, let us have the fortitude to hope that "freedom from want" will eventually mean also freedom from unhealthy food. Good health is not only desired by every American citizen, he is also entitled to have it. If we believe that "science goes from strength to strength to dominate the lives of men," to use words by E. W. Sinnott,[14] let us not forget that, in its application, "science has the power to work us infinite good or ill. The mastery it gives of energy and material things may send our race careening to its doom unless we gain the wisdom and the sanity to control our course."

OBITUARY

THOMAS MIDGLEY, JR.

An Appreciation

IN the passing of Thomas Midgley, Jr., on November 2, the American Chemical Society lost its president and the long-time chairman of its board of directors, and the nation lost one of its most creative men. Also those of us who were fortunate enough to know him personally lost a friend who held the highest place in our affection and esteem. Although only fifty-five when he died, Midgley had crowded into his lifetime an immense amount of accomplishment, and the achievements he left behind are an important legacy to the world.

Among the several contributions of Midgley and his associates, these four are particularly noteworthy:

He discovered the chemical antiknock agents. Tetraethyl lead, the principal one of these, is added to most automobile gasoline and it is also an essential ingredient of all high-octane aviation gasoline, so vital to-day.

As bromine in large amount is a necessary complement to lead in gasoline, he conceived and demonstrated the possibility of extracting it from the ocean, although it is present there in concentration so minute as to be measured in parts per million.

He made an altogether new series of refrigerating gases, based upon the unpromising element, fluorine, which are at once nontoxic and noninflammable.

He conducted intensive researches on rubber which extended the knowledge of the chemistry of vulcanization and of the composition of natural and synthetic rubbers.

How it happened that Thomas Midgley, Jr., a man trained not in chemistry but in mechanical engineering, came to make all these important advances in chemistry, is one of the unusual stories in modern research.

Midgley was born in Beaver Falls, Pa., on May 18, 1889. He attended high school in Columbus, Ohio, and at Betts Academy, Stamford, Connecticut. Then in 1911 he graduated from Cornell University with the degree of mechanical engineer. Out of college, he was employed at the National Cash Register Company. There he served as a draftsman in Inventions Department Number Three, the same department which I myself had left only two years before to develop a system of battery ignition and the self-starter for automobiles. After about a year at the National Cash Register Company, he left there, first to do some research on tires, and then to be successively chief engineer and superintendent of the Midgley Tire and Rubber Company, of which his father, Thomas Midgley, Sr., was general manager. In 1916, Midgley, desiring to go into research, applied for a position in our Dayton Engineering Laboratories Company. And thus began an association between us which lasted for nearly thirty years.

[14] E. W. Sinnott, *Am. Scientist*, 32: 205, 1944.

The first thing he did for us was to finish up the development of a simple mechanical means of indicating the degree of charge of a storage battery. Next he made some improvements on mercury-cooled exhaust valves. Then at my suggestion he began his long and important research on knock, the noisy and destructive bugbear which stood as a barrier to getting higher powers and better efficiency out of the gasoline engine. It was by means of a Dobbie-McInnes manograph that he made his first approach to that problem. The manograph was one that I had obtained some time before with the hope of finding opportunity to study the problem of knock, which by that time had become a serious one in automobile engines, and which I had encountered again in the effort then being made to develop a farm-lighting set. By means of this instrument mounted on a Delco-Light engine, Midgley soon found that knock did not come from preignition, as was generally believed then, but that it was a violent pressure disturbance which occurred late in the combustion of the charge, and not until some time *after* ignition by the spark plug.

In trying to understand why that violent combustion disturbance occurred, we surmised that it might result from an uneven combustion coming from imperfect vaporization of the fuel. Working on this theory, Midgley dyed the fuel red. There having been no dyes handy, he got the color with iodine; and, to his astonishment, the knock disappeared. As this observation seemed too simple to be credible, he next tried some true dyes that were soluble in the fuel and found that they had no effect upon knock whatever. But in the experiments he had discovered that iodine, either of itself or combined in the form of the colorless compound, ethyl iodide, did stop the knock.

At this point came the first World War, and Midgley's attention was turned to an effort, pursued in cooperation with the Bureau of Mines, to produce a better—more nearly knock-free—aviation gasoline. The extensive investigation made then showed for the first time that the behavior of a fuel in respect to knock is controlled not by physical characteristics, such as gravity and volatility, as had been supposed, but by the chemical structure of its components. From the results of this investigation, it was decided that a mixture of cyclohexane and benzene would best combine a good degree of freedom from knock with the possibility of being produced in simple fashion, for that could be done by hydrogenating benzene. After overcoming several obstacles, one of which was the destructive effect of sulfur on the catalyst, this endeavor had reached a stage of progress at which it was just ready to be put to practical use when the Armistice came. But the product, a mixture of 70 parts cyclohexane and 30 parts benzene, represented the first synthetic high-octane aviation fuel.

Although neither the discovery that iodine is an antiknock agent nor the making of an improved fuel by hydrogenating benzene was ever put to practical use, they did have an important effect. And that was to change Midgley's interest and activity after the war from mechanical pursuits to the chemical endeavors in which he proved to be so versatile and creative. Having been blessed with initiative and drive, and being unhampered by precedent, he soon became one of the best informed among chemists, and one of the most productive as well. Fortunately, he had that measure of intelligent ignorance—ignorance that the thing undertaken could not be done—which is so often needed for success in pioneering research.

So, after the war, Midgley began his career in chemistry by taking up again the search for a chemical antiknock agent. This "fox hunt," as he called it, was pursued for three years more in an intensive manner before the discovery of tetraethyl lead was made, and then for about two years longer before the several problems of using lead in an engine were solved in a satisfactory manner. It was during this latter period that the work on getting bromine out of the ocean was done also. After spending some years more in commercializing the tetraethyl lead development, he went back to the research laboratory. And there in due time he made his contributions to refrigerants and to rubber, already mentioned.

Having been a many-sided person, Midgley did not limit his accomplishments to those named. He also developed the Midgley Optical Gas Engine Indicator and the extensively used bouncing-pin indicator. He was a pioneer in the investigation of engine flames by visual observation through a window, by spectroscopic means, and by measuring the radiant energy emitted. He discovered some of the earliest cracking catalysts. In the present war, he was a member of the National Inventors Council and head of one branch of chemical endeavor for the National Defense Research Committee. In the first World War also he had a large part in the development of the aerial torpedo, now called the "buzz bomb."

For his many contributions Midgley received an unusual number of honors and awards, some of which were these: The Nichols Medal of the New York Section, American Chemical Society, 1922; the Longstreth Medal of the Franklin Institute, 1925; the Perkin Medal of the Society of Chemical Industry, 1937; the Priestley Medal of the American Chemical Society, 1941; the Willard Gibbs Medal of the Chicago Section, American Chemical Society, 1942.

He was elected an honorary member of the National Academy of Sciences in 1942, and he received the honorary degree of doctor of science from the College of Wooster in 1936 and from the Ohio State University in 1944.

In the citation read by William Lloyd Evans when Midgley received the latter of the two degrees was the following:

> The research work of Mr. Midgley has received wide recognition, as is evidenced by the great number of distinctions which have come to him from those groups best qualified to evaluate his contributions to human knowledge. Through experience, the layman will also testify his indebtedness to one who has contributed so greatly to more pleasant and efficient living. He has made science a liberator, and we rejoice with him in the satisfactions that must be his in seeing the fruits of his labor. Posterity will acknowledge their permanent value.

Some of the fruits of his labor are these: the millions of horsepower added to automobile engines, and particularly to aircraft engines in this war, by his discovery of the antiknock agent, tetraethyl lead, and by the impetus he gave to getting bromine out of the sea as a needed complement to lead in gasoline; the big boost given to refrigeration and air conditioning by his discovery of a non-inflammable and completely nontoxic refrigerant, as well as the unforeseen but fortunate dividend from that advance of the great usefulness of the same nontoxic gas for dispersing insect repellents in the atmosphere of the living quarters of our soldiers in tropical countries; and the employment given to thousands of people by the new industries which, through his discoveries, he did so much to bring into being.

Midgley had a large part in the business side of these endeavors too. He was vice-president of the Ethyl Corporation, and of Kinetic Chemicals, Inc. (freon). He was also a director of the Ethyl-Dow Chemical Company (bromine from the sea). Midgley was particularly effective in selling the products of research to people. Something of his ability in salesmanship or showmanship has been seen by those who have heard him present papers at scientific meetings. In giving his first paper on the antiknock agents, for instance, he made striking demonstrations of knock and of its removal by antiknock agents, both in a glass tube and in an engine. Also in reporting on his discovery of the fluorine-containing refrigerants he demonstrated both their nontoxic and their non-inflammable properties by breathing in some of the vapor and exhaling it softly to extinguish a burning candle.

Midgley was a firm believer in the value of scientific societies. He was a member of the American Association for the Advancement of Science, the American Chemical Society, the American Institute of Chemical Engineers, the Society of Automotive Engineers, the American Society for Testing Materials and the Society of Sigma Xi, as well as of several other organizations. He was particularly active in the American Chemical Society. He served on its committees, he took part in local section affairs, he became a member of the board of directors in 1930 and chairman of the board in 1934, and he was president of the society in 1944. Speaking in 1937 of Midgley's large service to the American Chemical Society, Robert E. Wilson said this: "Having served as fellow director and under his chairmanship during the past five years of heavy stress for professional societies as well as business organizations, I can testify that his work and judgment have been invaluable to that organization."

Midgley was, of course, a strong believer in research also. In a paper presented less than a month before his death he said, "I am of the opinion that, as time goes on, more and more research of the fundamental type will be necessary." And, as an insurance that there will be trained men to conduct such research, he advocated that "by ample fellowships both in size and number, it (industry) should encourage many young men to remain in educational work."

The period of Midgley's researches covered only twenty years. But into these twenty years he compressed an immense amount of activity. Even after an attack of poliomyelitis in 1940 had made him a semi-invalid, he continued his interest and activity in the field of research, as well as his large service as an executive officer of the American Chemical Society and of other organizations. And this was in entire keeping with the intensive and remarkably useful life he lived. As a closure for his presidential address, "Accent on Youth," presented before the American Chemical Society less than two months before he died, Midgley used an original poem, of which these were the last two lines:

> Let this epitaph be graven on my tomb in simple style,
> "This one did a lot of living in a mighty little while."

CHARLES F. KETTERING
RESEARCH LABORATORIES DIVISION,
GENERAL MOTORS CORPORATION,
DETROIT

RECENT DEATHS

DR. JOHN MADISON FLETCHER, professor of psychology at Tulane University, died on December 12 at the age of seventy-one years.

DR. HOWARD ADAMS DOBELL, head of the department of mathematics at the State College for Teachers at Albany, N. Y., died on December 8 at the age of forty-eight years.

SCIENTIFIC EVENTS

PRESENTATION OF THE NOBEL PRIZES

NOBEL Prizes were presented at a luncheon of the American-Scandinavian Foundation at the Waldorf-Astoria Hotel in New York City on December 10. Addresses were made by Wollmar F. Boström, Minister of Sweden, and by Dr. Harold W. Dodds, president of Princeton University. The recipients of the prizes were:

DR. OTTO STERN, a member of the faculty of the Carnegie Institute of Technology, Pittsburgh, was born in Germany and came to the United States in 1933. At present he is engaged in work for the American Government. To him has been awarded the 1943 Nobel Prize in Physics with the following citation: "For his contributions to the atomic ray method and his discovery of the magnetic moment of the proton."

DR. ISIDOR I. RABI, professor of physics at Columbia University, was born in Austria and brought to the United States in infancy. At present he is associate director of the Radiation Laboratory at the Massachusetts Institute of Technology. To him has been awarded the 1944 Nobel Prize in Physics: "For his resonance method of recording the magnetic properties of the atomic nuclei."

DR. JOSEPH ERLANGER, professor emeritus of physiology of Washington University, St. Louis, was born in San Francisco in 1874. To him has been awarded one half of the 1944 Nobel Prize in Physiology and Medicine: "For his discoveries concerning the highly differentiated functions of single nerve fibers."

DR. HERBERT SPENCER GASSER, director of the Rockefeller Institute for Medical Research, New York, was born in Platteville, Wis., in 1888. To him has been awarded the other half of the 1944 Nobel Prize in Physiology and Medicine: "For his discoveries concerning the highly differentiated functions of single nerve fibers."

DR. EDWARD ADELBERT DOISY, professor of biochemistry at the St. Louis University School of Medicine, was born in Hume, Illinois, in 1893. To him has been awarded one half of the Nobel Prize for 1943 in Physiology and Medicine: "For his discovery of the chemical nature of Vitamin K."

DR. HENRIK DAM, professor of biochemistry at the Copenhagen Institute of Technology, came to the United States in 1940 as a fellow of the American-Scandinavian Foundation, and is now continuing his research work in vitamins and allied subjects at the University of Rochester School of Medicine. To him has been awarded one half of the Nobel Prize for 1943 in Physiology and Medicine: "For his discovery of Vitamin K."

DR. GEORGE VON HEVESY left his native Hungary about ten years ago to work with Niels Bohr, winner of the 1922 Nobel Prize in Physics, in Copenhagen, Denmark. He is now continuing his research work in Stockholm, Sweden. To him has been awarded the 1943 Nobel Prize in Chemistry. (His citation has not yet been published.)

JOHANNES V. JENSEN, born in 1873 at Farsoe, Denmark, is the author of more than sixty volumes of poetry, plays, short stories and novels. To American readers the best known are "The Fall of the King" and "The Long Journey." A study of his work by Signe Toksvig appeared in *The American-Scandinavian Review* for December, 1943. See also a review of his book about the United States, "The Free States," by Francis Hackett, *The New York Times*, November 23, 1944. Mr. Jensen is now living in Copenhagen. (His citation has not yet been published.)

The Nobel Prizes were established by the late Alfred Bernhard Nobel, a Swedish inventor, who lived most of his life in Paris. He was born in Stockholm in 1833 and died in San Remo, Italy, on December 10, 1896. His will, signed the year before in Paris, was composed by himself and written out in his own hand in Swedish. It disposed of an estate worth about $10,000,000.

The value of the prizes fluctuates, as a rule, between $30,000 and $40,000, depending on the income earned by the fund, which is invested in Swedish securities. The prizes were first given out in 1901, but by special permission from the Swedish Government, the distribution of all prizes has been omitted in wartime, both during the first world war and so far during the second. The peace prize has not been given out since 1938. Any prize, omitted one year, can be given out the next. If omitted more than a year it reverts to the main fund or to special funds to support work in corresponding fields.

GRANTS OF THE NATIONAL FOUNDATION FOR INFANTILE PARALYSIS

AT the Annual Medical Meeting held on September 11 and 12 of the the Board of Trustees of the National Foundation for Infantile Paralysis, grants amounting to $143,931 were approved. These are as follows:

VIRUS RESEARCH

University of California, The George Williams Hooper Foundation, San Francisco	$30,000
Stanford University School of Medicine, San Francisco	12,460
Michigan Department of Health, Lansing	12,620
University of Pennsylvania, Philadelphia	10,000

AFTER-EFFECTS RESEARCH

Columbia University, College of Physicians and Surgeons, New York City	6,600
Massachusetts General Hospital, Boston	6,000
The State University of Iowa, College of Medicine, Iowa City	5,000
University of Toronto, School of Hygiene	4,538

EDUCATION	
The American Association of Medical Social Workers, Chicago	35,000
University of Minnesota, the Medical School, Minneapolis	9,213
Children's Hospital Society, Los Angeles	5,700
The American Physiotherapy Association, New York City	5,000
Teachers College, Columbia University, New York City	1,800

FELLOWSHIPS IN THE MEDICAL SCIENCES OF THE NATIONAL RESEARCH COUNCIL

FELLOWSHIPS in the Medical Sciences, similar to those which have been administered by the Medical Fellowship Board of the National Research Council since 1922, will again be available for the year beginning July 1, 1945. These fellowships, supported by grants from the Rockefeller Foundation to the National Research Council, are designed to provide opportunities for training and experience in research in all branches of medical science. They are open to citizens of the United States or Canada who possess an M.D. or a Ph.D. degree, and are intended for recent graduates who are not yet professionally established.

In addition to these fellowships the Medical Fellowship Board administers two groups of research fellowships, made available through a grant from the National Foundation for Infantile Paralysis, Inc. The first group, open to applicants who hold either the Ph.D. or M.D. degree, is for the purpose of providing opportunities for special training and experience in the study of filterable viruses. The second group, open only to graduates in medicine who have completed one or more years of hospital experience in clinical surgery and are planning a career in orthopedic surgery, is designed to provide opportunities for training and research in those basic medical sciences which will be of particular value in furthering progress in the field of orthopedic surgery.

Fellows will be appointed at a meeting of the Medical Fellowship Board late in February, 1945. Applications to receive consideration at this meeting must be filed on or before January 1. Appointments may begin on any date determined by the board.

For further particulars concerning these fellowships, address the Secretary of the Medical Fellowship Board, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

THE NEW YORK ACADEMY OF SCIENCES

THE one hundred and twenty-seventh annual meeting of the New York Academy of Sciences was held on December 14 at the American Museum of Natural History.

At this meeting presentation was made of the two annual A. Cressy Morrison Prizes of the value of $200 each "for the two most acceptable papers in any field of science, within the scope of the academy and its affiliated societies." Dr. Eleanor Alexander-Jackson, of the Department of Public Health and Preventive Medicine of the Cornell University Medical College, New York, received the award in recognition of her work on the tubercle bacillus,[1] and Dr. Alexander Sandow, of the department of biology of New York University, for his paper on the mechanism of muscular contraction.

Two other papers received honorable mention "for their general excellence," one by Dr. Lela V. Barton, of the Boyce Thompson Institute for Plant Research, Yonkers, N. Y., on "respiration and germination studies of seeds in moist storage," and the other by Dr. William A. Ritchie, Rochester, N. Y., Museum of Arts and Sciences, on "an early site in Cayuga County, N. Y., type station of the Frontenac Focus, Archaic Pattern."

Dr. Peter Debye, professor of chemistry at Cornell University, gave the principal address.

Dr. Walter H. Bucher, professor of geology at Columbia University, was elected president of the academy. New vice-presidents elected were Dr. Joseph S. Fruton, associate in chemistry of the Rockefeller Institute for Medical Research, and Dr. Raymond L. Zwemer, of the Division of Cultural Relations of the Department of State, Washington.

Dr. Florence Sabin, member emeritus of the Rockefeller Institute for Medical Research; Professor Robert H. Lowie, professor of anthropology at the University of California, and Professor Paul Niggli, professor of mineralogy and petrography at the University of Zurich, were elected to honorary life membership.

IN HONOR OF JAMES MURRAY LUCK

AT a meeting of the Executive Committee of the Pacific Division of the American Association for the Advancement of Science, held in San Francisco on November 17, the following resolution was adopted:

The Pacific Division of the American Association for the Advancement of Science, through its Executive Committee, expresses to Professor James Murray Luck, of Stanford University, its appreciation of his services as Secretary of the Pacific Division from 1929 to 1944.

Through a period of fifteen years of continuous growth in the membership of the Division, with a corresponding increase in the duties and responsibilities of the Secretary, Professor Luck carried on the work of his office with a quiet efficiency equalled only by his unfailing graciousness, good-humor and goodwill. It should not pass without remark that, at the urgence of the Executive Committee, he continued in the secretaryship a number of years after he had expressed a desire

[1] See SCIENCE, April 14, 1944, p. 307.

to withdraw from the position. His resignation, necessitated by the pressure of other duties, is accepted with regret. The good wishes of the officers and members of the Pacific Division go with him.

It was moved, seconded and unanimously carried that the foregoing resolution be spread upon the minutes, a copy transmitted to Dr. Luck, and a copy sent to the editor of SCIENCE.

SCIENTIFIC NOTES AND NEWS

DR. CHARLES LATHROP PARSONS, for thirty-seven years secretary of the American Chemical Society, formerly chief chemist of the U. S. Bureau of Mines, received on December 17 the honorary degree of doctor of science from the University of New Hampshire, where from 1892 to 1911 he was a professor of chemistry. The degree was conferred at ceremonies held on the occasion of the inauguration of Harold Walter Stoke as tenth president of the university.

PROFESSOR DETLEV W. BRONK, director of the Johnson Research Foundation of the University of Pennsylvania and coordinator of research in the Office of the Air Surgeon, headquarters of the Army Air Forces, delivered in Paris on November 3 the Liberation Lecture of the Société Philomathique de Paris. He was awarded the medal of the society. Dr. Bronk has recently returned from a military mission in France, Belgium and England.

THE Edison Medal for 1944 of the American Institute of Electrical Engineers has been awarded to Dr. E. F. W. Alexanderson, consulting engineer of the General Electric Company, "for his outstanding inventions and developments in the radio, transportation, marine and power fields." The presentation will take place on January 24 at a joint session with the Institute of Radio Engineers, during the winter technical meeting of the institute.

THE annual Captain John H. Linnard Prize for 1943 of the Society of Naval Architects and Marine Engineers has been presented to Professor C. Richard Soderberg, of the Massachusetts Institute of Technology, and Ronald B. Smith, director of research and development of the Elliott Company, Jeannette, Pa., for an article on the gas turbine as a possible marine prime mover.

THE Osborne Medal of the American Association of Cereal Chemists, awarded for distinguished contributions to cereal chemistry and related sciences, will be conferred at Toronto at the forty-fifth annual meeting of the association on Dr. John Clark Baker, vice-president and director of research at Wallace and Tiernan Company, Inc.

DR. WILLIAM H. ROSS, of the Bureau of Plant Industry and Soils of the U. S. Department of Agriculture, has been elected president of the Association of Official Agricultural Chemists.

PROFESSOR SAMUEL J. RECORD, dean of the School of Forestry of Yale University, will retire on June 30. He will be succeeded by Professor George A. Garratt, a member of the faculty of the school. Professor Record will continue his work as professor of forestry.

WILLIAM E. STANLEY, professor of sanitary engineering at Cornell University and consulting sanitary engineer, has been appointed professor in charge of sanitary engineering at the Massachusetts Institute of Technology.

DR. CHARLES A. DOAN, since 1936 chairman of the department of medicine of the Ohio State University, has been made dean of the College of Medicine and director of the University Hospital. Dr. Hardy A. Kemp, formerly dean, who has leave of absence for work at the Army Medical School at Washington, will on his return to the university become professor of public health and hygiene.

DR. JOSEPH C. BOYCE, technical aide and section chief for the National Defense Research Committee of the Office of Scientific Research and Development, has been appointed professor of physics and chairman of the department of physics of the College of Engineering of New York University. From 1932 to 1941 he was a member of the department of physics of the Massachusetts Institute of Technology.

AT a recent meeting of the Board of Directors of Washington University, St. Louis, approval was given to the reorganization of the department of geology and geography as two separate departments. Dr. Lewis F. Thomas has become head of the department of geography, and Dr. Carl Tolman, who is on war leave with the Foreign Economic Administration, of the department of geology.

DR. DAVID F. MARSH, assistant professor of pharmacology at the School of Medicine of the University of Georgia, Augusta, has been appointed associate professor of pharmacology and head of the department of the School of Medicine of the University of West Virginia at Morgantown.

DR. WILLIAM HAMPTON MARSHALL has been appointed associate professor of entomology and economic zoology in charge of the work in game management and wildlife conservation at the University of Minnesota. He succeeds Dr. Gustav Swanson, who

recently became biologist in the U. S. Fish and Wildlife Service.

EARLE B. PHELPS, professor emeritus of sanitary science of the College of Physicians and Surgeons of Columbia University, has become research engineer at the Engineering and Industrial Experiment Station of the University of Florida.

AT the School of Economics of the University of London, Dr. R. W. Firth has been appointed to the university chair of anthropology. Since 1941 he has been in government employment at the Admiralty, and last July he was appointed secretary to the Colonial Social Science Research Council. Dr. R. G. D. Allen has been appointed to the university chair of statistics. Since 1940 he has been in the United States on Government service, and is at present British director of statistics to the Combined Production and Resources Board at Washington.

BRIGADIER GEORGE MACDONALD, emeritus professor of physiology of the University of Liverpool, has been appointed director of the Ross Institute of Tropical Hygiene of the London School of Hygiene and Tropical Medicine. He has been assistant director of the institute since 1939.

DR. ROBERT P. FISCHELIS, director of the Division of Drugs, Chemicals and Health Supplies in the Office of Civilian Requirements of the War Production Board, has been elected to succeed on January 1 the late Dr. E. F. Kelly as secretary and general manager of the American Pharmaceutical Association.

HOWARD ROSS TOLLEY, chief of the Bureau of Agricultural Economics of the U. S. Department of Agriculture, has been designated as the American representative on the Interim Food Commission of the United States.

The Experiment Station Record reports that Dr. J. H. Martin, head of the department of poultry husbandry at Purdue University, has leave of absence for a year to serve as director of experiments in animal breeding for the DeKalb Agricultural Association, Inc., of Illinois.

Chemical and Engineering News states that General A. G. L. McNaughton, who had leave of absence to serve as General Officer Commanding the Canadian Army Overseas, has returned to Canada. He has resigned his post as president of the National Research Council of Canada to which he was appointed in 1935, and has been sworn in as senior Minister of National Defense. C. J. Mackenzie, dean of the faculty of engineering at the University of Saskatchewan, and since 1939 acting president of the National Research Council of Canada, has been appointed president in succession to General McNaughton.

AT the Virginia Fisheries Laboratory of the College of William and Mary Dr. John G. Mackin, of the East Central State Teachers College, has been appointed associate biologist; Mrs. Ruth Ellis Allen and Miss Rosalie Rogers have been made research assistants.

COLONEL ESMOND R. LONG, Medical Corps, Army of the United States, Office of the Surgeon General, will deliver on the evening of January 8 at the Palmer House the ninth Christian Fenger Lecture of the Institute of Medicine of Chicago and the Chicago Pathological Society. His subject will be "Tuberculosis as a Military Problem."

DR. CHUNG CHIEN YOUNG, of the Caenozoic Research Laboratory of the Chinese Geological Survey, addressed on December 7 members of the departments of biology and geology of the University of Kansas.

DR. HENRY B. COLLINS, JR., ethnologist of the Bureau of American Ethnology of the Smithsonian Institution, has been appointed director of the Ethnogeographic Board to succeed Dr. Wm. Duncan Strong, who has returned to Columbia University to resume his work as professor of anthropology. The Ethnogeographic Board was established in 1942 under the joint sponsorship of the National Research Council, the American Council of Learned Societies, the Social Science Research Council and the Smithsonian Institution. Its primary function is to make accessible to Washington military and war agencies such specific regional information and evaluated personnel data as may be available to the sponsoring institutions and other scientific organizations with which they are affiliated or in contact. The offices of the board are in the Smithsonian Institution Building in Washington. Its present members are Carl E. Guthe, New York State Museum, *chairman;* Wendell C. Bennett, Yale University; Isaiah Bowman, the Johns Hopkins University; Carter Goodrich, Columbia University; John E. Graf, the U. S. National Museum; Mortimer Graves, the American Council of Learned Societies, and Wm. Duncan Strong, Columbia University.

DR. CARL C. LINDEGREN, of Washington University, St. Louis, recently addressed the Chapter of the Society of Sigma Xi of Purdue University. He spoke on "The Improvement of Industrial Yeast." He also made an address before the Biology Club on "The Inheritance of Adaptive Enzymes in Yeast."

THE Lavoisier Bicentenary lecture was delivered on November 16 before the Royal Society, London, by Sir Harold Hartley, F.R.S.

THE Astronomer Royal, Sir Harold Spencer Jones, will give the one hundred and fiftieth course of Christmas lectures adapted to a juvenile audience at the Royal Institution on December 28 and 30 and January

2, 4, 6 and 9. The title of the course will be "Astronomy in Our Daily Life."

THE sixth annual scientific award of the American Pharmacological Manufacturers' Association was presented at the meeting held in New York on December 11 and 12 to the National Research Council in recognition of its "fundamental contributions to public health in the field of the medical sciences; and also in recognition of its essential services to our country in World Wars I and II." The nominating report was made by Dr. George R. Cowgill, professor of nutrition at Yale University. Dr. Alan Gregg, director of medical sciences, of the Rockefeller Foundation, made the presentation address. It was entitled "The Essential Need of Fundamental Research in Medical Sciences for Social Progress." Dr. Ross G. Harrison, chairman of the National Research Council, accepted the award. He spoke on the "National Research Council and Its Action in the Field of the Medical Sciences." Dr. Frank B. Jewett, president of the National Academy of Sciences, made the concluding statement.

THE tenth award of the Oberly Memorial Fund, in memory of Eunice Rockwood Oberly, will be made in the spring of 1945. This prize is awarded every two years to the compiler submitting the best bibliography in the field of agriculture or the related sciences. The amount of the prize is approximately $100, the interest on the fund for two years. It is administered by the American Library Association. Those submitting bibliographies in competition for the prize should send four typewritten or printed copies to the chairman of the committee before March 1, 1945. The bibliography must be accompanied by a letter stating that it is being submitted in competition for the Oberly Memorial Award, 1944–45. The members of the committee are Nelle Uree Branch, Mary G. Burwash, Marvin A. Miller, Caroline E. Reinke and Margaret C. Schindler. W. P. Kellam, librarian of the University of West Virginia, Morgantown, is chairman.

IT was recently stated in SCIENCE that Nobel Prizes were to be presented in the United States for the first time on December 10. A correspondent calls our attention to the fact that the Nobel Prize in Physics for 1939, awarded to Professor Ernest O. Lawrence, of the University of California, was presented to him at the University of California in Berkeley on February 29, 1940. The presentation was made on behalf of King Gustavus V by Mr. Carl E. Wallerstedt, Consul-General of Sweden in San Francisco.

DISCUSSION

THE MAGNIFICATION OF DIFFERENCES BY A THRESHOLD

CONSIDERING the political implications of the subject, the discussion in SCIENCE regarding the effect of heredity upon human physiology and psychology has been carried on with unusual clarity and objectivity, and it is likely that all who have taken part in it would agree that in everyday life we need to encourage a respect for human differences, whether caused by culture, physical and biological environments or heredity. As Mead[1] has put it, we may assume that each human group has something of value to contribute to mankind as a whole.

The problem discussed is part of a much larger one, the effect of heredity upon the behavior of any animal, and on this basis it is possible to be somewhat more objective.

That heredity can affect behavior is a matter of fact. The well-known cases of the waltzing mice which run endlessly in narrow circles, of the vestigially winged Drosophila which can not fly and the nervous disease of Huntington's chorea among human beings represent a few of many obvious examples. But these bizarre cases are also rare, and there remains a problem of determining just how important hereditary effects may be. The author has made certain experiments along these lines on fruit-flies[2] and house mice[3] which indicate one special type of conditions in which heredity may produce important results.

Professor Dobzhansky[4] has admirably summarized the theoretical reasons for believing that variability of behavior caused by heredity should be relatively very small compared to that produced by environmental factors. This expectation has been confirmed and the author has been struck by the difficulty of finding differences caused by heredity and the ease with which they could be modified by slight changes in the environment. Among the mice two inbred strains were found in which (under special conditions) one type of male would react peaceably and the other aggressively to a strange mouse. Later it was found that either strain could be trained in a few days to either fight fiercely or be wholly pacific.

However, one very interesting situation was observed, that in which the ordinarily minor effects of heredity appeared to be magnified by a threshold. Among the fruit-flies it was found that in a given

[1] "And Keep Your Powder Dry." New York: Morrow & Co. 1942.

[2] *Am. Naturalist*, 77: 184–190, 1943.
[3] *Jour. Heredity*, 33: 11–15, 1942.
[4] SCIENCE, 100: 406, 1944.

stock under conditions of weak illumination the possession of red or white eyes might make the difference between a fly's crawling toward the light or not crawling at all, an enormous difference in behavior, whereas under other conditions the same factor might produce little effect. It also seems likely that the large behavior difference observed in mice was associated with a threshold of training.

The sort of situation in which heredity may shift the threshold of stimulation or performance is theoretically possible in any animal. Human life (at least in the United States) appears to have many threshold situations, from athletic contests to social barriers. Acting as a "last straw" in certain special environments it is possible that heredity may produce in the behavior of human individuals differences whose importance is all out of proportion to its general effect.

Certain words of caution regarding this suggestion need to be spoken. Differences produced by environmental factors may also be magnified by a threshold. Because of the presumably greater powers of learning of human beings it must be expected that heredity will be found to have smaller effects upon behavior than in the lower animals. Furthermore, this idea applies only to individuals under special conditions and does not apply to large groups with variable heredity and environments.

J. P. SCOTT

WABASH COLLEGE

PHOTOGRAPHY OF CRYSTAL STRUCTURES

SIR LAWRENCE BRAGG[1] has shown that Fourier series summations of x-ray diffraction data from a crystal can be made optically, yielding "photographs" of the crystal structure, in which the individual atoms are seen in their proper relative positions. The method is essentially a superposition of exposures of patterns of light and dark bands, the choice of band patterns and the lengths of exposure being determined by the x-ray data.

As shown previously by the writer,[2] this method can be made much easier and faster by the use of a previously prepared set of masks, on which the proper patterns are printed. The same set serves for all structures and for both electron density summations and Patterson summations. A set of 316 such masks, on a roll of 35 mm film, has recently been prepared in these laboratories. With it, pictures of structures for which suitable x-ray data are available can easily be made in a half hour. Magnifications of 100,000,000 or more are readily obtained.

Although the accuracy of atomic positions and of relative electron density values at different points in the structure is undoubtedly less than can be obtained by computational methods, the ease and speed of the photographic method should make it useful both in working out new structures and as an aid in the description of structures which have already been deduced.

We hope soon to be able to furnish duplicate copies of our new set of masks, at a nominal cost, to others engaged in crystal structure analysis.

MAURICE L. HUGGINS

KODAK RESEARCH LABORATORIES,
ROCHESTER 4, N. Y.

[1] W. L. Bragg, *Z. Krist.*, A70: 475, 1929; "The Crystalline State," p. 229, London and New York: Macmillan. 1934.

[2] M. L. Huggins, *Jour. Am. Chem. Soc.*, 63: 66, 1941.

HUMAN GENETICS AND ANTHROPOLOGY

ANTHROPOLOGISTS and human geneticists have many problems in common, and it would seem that they would see eye to eye on major issues. They probably do on most, but apparently not on all. At least in recent comments in SCIENCE Professors Herskovits[1] and Ashley Montagu[3] have questioned the actuality or even the reasonableness of the existence of physiological and inherent response differences between major subdivisions of the human species.

In my comment[2] on Professor Herskovits's note I wrote: "If primary human stocks (Mongoloid, Negroid and Caucasoid) and if subdivisions of these major groups ('races') have any validity at all, and the author believes that Professor Herskovits will admit that they do have some, it seems almost inevitable that both physiological and inherent response differences must exist." In a later issue of SCIENCE Professor Ashley Montagu[3] commented as follows: "At first blush this seems a reasonable enough statement but when one inquires why it appears to be so it will be found that it is suspected that physical characters are probably linked with functional ones, that there is a genetic linkage between the genes for the two different orders of phenomena." He continues: "If such is the ground upon which this assumption is usually made then it ceases to be a reasonable one, for the good reason that it is based on no more than a suspicion or a hunch and not upon facts which are known to exist or have been demonstrated." He adds later, "Genetic linkage between particular physical traits and particular psychological traits is a phenomenon unknown outside folk belief."

May I add at once that the reason presented by Professor Ashley Montagu is not the one which makes it seem almost inevitable that inherited physiological and psychological differences exist between primary human stocks and races. In fact, the reason he presents has no bearing on the question at issue. The

[1] SCIENCE, n.s., 100: 457–461.
[2] SCIENCE, n.s., 100: 146–147.
[3] SCIENCE, n.s., 100: 383–384.

reasoning on a basis of which my original statement was made is this: Physical differences which characterize primary human stocks and races are in a large measure a consequence of chance samplings of hereditary materials which took place at the time ancestral groups separated, plus accumulations of different new variations in hereditary materials which have occurred since the groups became isolated. Many physiological and response differences within the human species have been shown to have some genetic basis (see below), therefore one should also expect that chance samplings and accumulations of different new hereditary materials would have taken place with respect to them.

Professor Ashley Montagu may question the existence of physiological and response differences between human individuals which have some genetic basis, but the evidence for such differences is accumulating rapidly. As a matter of fact what are inherited physical differences between individuals and races but expressions of physiological differences? Surely in this day and age no one believes that black hair or blond hair are inherited as such from mother or father. What is inherited is a set of chemical materials (genes) representative of black or blond hair, which through physiological processes are responsible for the production of a particular type or amount of pigment. Inherited physiological differences in this sense, therefore, exist without question. Inherited physiological or response differences which can not or have not been expressed in terms of readily seen physical manifestations are not as readily cited, but even many of this type could be listed. For example, one could mention: (1) inherited differences in metabolic processes with respect to the formation of alcapton, porphyrin, albumin, etc.; (2) inherited differences in blood characteristics (A–B, M–N, hemophilia, sickle cell anemia, Rh, etc.); (3) inherited differences in taste (P.T.C.); (4) inherited differences in vision (color blindness, night-blindness, myopia, etc.); (5) inherited differences in response patterns (ataxias, choreas, oligophrenias, etc.). Many more could be listed. I have chosen only some of the better known ones.

Now it is only fair to state that only a few physiological or response characteristics, even of those listed above, have been studied from a racial point of view, but of those which have been investigated a fair number has been shown to be represented by racial differences. It is true that most of the differences observed are only differences in frequency of occurrence of the characteristic in question and therefore represent only a difference in gene frequencies, but even such differences are important to our understanding of the genetics of human populations.

What apparently plagues certain individuals is a fear that a study of racial differences will engender racist doctrines of superiority and inferiority. I appreciate this possibility and am in sympathy with that fear. However, I am equally fearful of opinions and tendencies which operate to close the door of investigation. I am convinced that as scientists we can best help check the growth of unwarranted dogmas by knowing what the facts are.

May I comment briefly on the argument presented by Professor Ashley Montagu relative to genetic linkage between traits. It apparently is a common notion among laymen and even scientists not familiar with genetic principles that characters which are linked should be found together in a population. That is true for a few generations only. In a population which has been breeding at random for a fairly large number of generations even linked characters should be distributed at random within that population.

I should not continue these discussions in SCIENCE on these matters of human inheritance were I not deeply concerned about the issues involved. Human genetics is developing rapidly at the present time, and I am of the opinion that much that it is discovering is for the good of humanity. For that reason alone it would be unfortunate if erroneous opinions prevailed and served as a check on present and future scientific studies within its realm. Anyway, physical anthropologists and human geneticists should agree on major issues and should work in harmony, because their fields of inquiry are closely allied. I believe that we can agree and work harmoniously if we are willing to air freely such differences in opinion as may exist.

HERLUF H. STRANDSKOV

DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF CHICAGO

DATA ON CANCER THERAPY

AT the Gibson Island Cancer Symposium in August, 1944, a suggestion was made that some one compile and publish all the data available relative to cancer therapy. Such a survey might be expected to aid other workers in planning systematic studies in this field of cancer research. The National Cancer Institute has offered to undertake this work.

All types of therapy except surgery and irradiation will be covered. Negative and positive results of the treatment of spontaneous, transplanted and induced experimental tumors, and of clinical cases, will be included. It has been found that negative results which have been obtained have not always been published. The data will be classified and tabulated in a simple manner similar to that in Hartwell's "Survey of Compounds Which Have Been Tested for Carcinogenic Activity," National Cancer Institute, 1941, and will include the name of the agent, the number of ani-

mals or patients treated, the dosage, route of therapy, number of treatments, the authors' conclusions regarding a beneficial effect, the percentage of complete regressions if obtained and the reference.

It would be appreciated if all available reprints of published work in this field or any unpublished results which may be used are sent to the undersigned.

HELEN M. DYER,
Research Fellow

NATIONAL CANCER INSTITUTE,
BETHESDA, MD.

THE NAPLES ZOOLOGICAL STATION

A RECENT letter which I have received from Dr. Reinhard Dohrn, director of the Stazione Zoologica at Naples, contains some items in addition to those given in Dr. Harrison's communication in SCIENCE of March 31. Dr. Dohrn reports that the station is in limited working order, and that the library, which had been taken to a place of security in the country, has now been returned, with the loss of a very few volumes. Since the libraries of the various university institutes have suffered great damage, the value of the station library is greater than ever before. It is being used considerably by scientific workers from the laboratories of biochemistry in the American military hospital. Unfortunately, some of the important instruments such as the spectrograph, the stufenphotometer and galvanometers have been seriously damaged. Dr. Dohrn indicates that the reestablishment of contacts with former workers at the station would be greatly appreciated and that expressions of interest by friends of the station would constitute valuable spiritual help at this particular time.

A. R. MOORE

UNIVERSITY OF OREGON

SCIENTIFIC BOOKS

THE RESEARCH LIBRARY

The Scholar and the Future of the Research Library. By FREMONT RIDER. xiii + 236 pp. New York: Hadham Press. 1944. $4.00.

IT is now ten years since microfilm copying was begun in an American research library as a means for the convenient, economical and efficient distribution of the periodical literature of science to those engaged in research. This application is still largely ignored by librarians who see only in micro copying technics a means for augmenting their collections.

In the present book, the author, who is librarian of Wesleyan University, goes very much further in this direction by proposing the micro-card republication of as much of the accumulated and current cultural and scientific literature as may be possible. The need for this is postulated on the evidence that representative college and university libraries in this country have doubled in size every sixteen years. At this rate, the library of Yale University, which in 1938 had 2,748,000 volumes, one hundred years hence will have approximately 200,000,000 volumes which will occupy over six thousand miles of shelves and require a staff of over six thousand persons.

A solution of this growth problem has been sought by such expedients as weeding out, use of storage warehouses, operational economies and cooperation among groups of libraries. None of these means has been found to more than scratch the surface of the problem. The solution proposed by the author consists in reducing the size of books to that of a library catalogue card. These micro-cards would have printed on the face, in addition to the name of the author, title, format, publisher and cataloguing indications, a résumé of the subject-matter of the publication. On the reverse of the card, there would be a micro-print reproduction of the complete book. In the case of periodicals there would be a separate card for each article published in them.

By this method, reference libraries would gradually be converted from bound volumes on shelves to catalogue cards in filing cases. The many advantages which would result are described in the most convincing manner. Impressive estimates are given of the economies which would result. In general, this is one of the most thought-provoking books about libraries which has appeared in recent years.

Due to the vast numbers of micro-cards which would have to be made under this plan, it is proposed to subdivide the work among libraries. The republication of existing and future cultural and scientific literature would thus become a library enterprise conducted as a special sort of publishing business. This is quite a departure from the generally accepted notion that both public and research libraries are public institutions, no activity of which is ever conducted on a commercial basis.

The technic by which micro-cards are made requires that two copies of each book be first trimmed of the margins surrounding the text. The separate leaves thus prepared are pasted with rubber cement in regular aligned sequence on a large 3×5 foot piece of binder's board. This composite sheet is then photographically reduced in size to the standard $7\frac{1}{2} \times 12\frac{1}{2}$ centimeter catalogue card. It is assumed that in editions of probably never less than five hundred copies the selling price will be five cents each.

The reader entering a library composed of micro-cards in filing cases would not have to wait, as at present, until the numerous charging and transporting steps, from call slip to final delivery, are completed. He would go directly to the filing cases in which the micro-cards are arranged in accordance with the most highly perfected cataloguing system, and when he has found the title he desires, the micro-card "book" would be withdrawn and a call slip inserted in its place. A duplicate call slip would be left with the attendant and the reader would go to read his "book" to any one of the numerous micro-card reading machines which "will be sprinkled freely, not only all over the library, but everywhere else around the university."

The question of copyright infringement is not considered a serious hindrance, since there are such vast ranges of material which were never under copyright at all and others on which copyright has long since expired. In the case of all others, satisfactory arrangements with authors and publishers would have to be made. These might possibly be on the basis of some guarantee that libraries will continue to purchase the originals in the usual number or provide a system of honoraria to recompense the holder of the copyright.

The author points out that it is the far less used source material of science which is in greatest need of being transferred to micro-cards. It is this, however, of which the original cost of publication is on the most precarious basis. Practically all scientific periodicals require the aid of subsidies of one kind or another. Any additional expenditure for their dissemination to the relatively few who use them can hardly be justified on the basis of solving the problem of library growth. Micro-cards are not substitutes for original publications, but supplements to them which are produced only at a cost which augments the total cost of publishing this class of literature. Just how great this may prove to be can not be estimated at present, but it is conceivable that it may well approach that required for providing the additional library buildings and paying the costs of caring for the innumerable books produced on an ever expanding scale. The net gain may, therefore, be very much less than the micro-card plan may at first appear to offer.

One other thought which the author's plan arouses is the tendency of librarians to regard their principal duty as that of improving the service they render to readers in the library. This is based on the assumption that the library itself is the place for scholars and scientists to go to do their best work. As a matter of fact, however, the conditions there are usually not as conducive to concentration, study and reflection as the privacy of one's own surroundings.

The purpose behind the micro-card plan is to improve library service. By means of these micro-cards, there will be set up the most perfect and convenient catalogues of research literature ever made. This of course is fine for those who can come to the library, but what about the far greater number who can not or who prefer to work in their homes or laboratories? For these, their index and catalogue requirements are at present served fairly well by printed, widely circulating publications, and their principal need is to obtain from the library with the least possible effort the source publications which they desire to study at their convenience. The plan of microfilm copying referred to at the beginning of this review is designed for this purpose and will permit librarians to render far greater service to far larger numbers of workers than is possible in any other manner.

The author mentions that "Collecting and holding, however important, are merely static functions of libraries: publishing and dissemination are dynamic functions." If the publishing is confined to single microfilm copies in numbers sufficient to meet the needs of individual workers, a far more efficient and economically justifiable dissemination of the source literature will be accomplished than by any plan of micro-card republication.

ATHERTON SEIDELL

ORGANIC CHEMISTRY

Organic Chemistry Simplified. By RUDOLPH MACY. $6\frac{1}{4} \times 9\frac{1}{4}$ in. viii + 431 pages. Bound in red cloth. Brooklyn: Chemical Publishing Company, Inc., 1943. $3.75.

THE author, in his preface, states that this book was written to provide a simpler and more gradual introduction to the subject of organic chemistry, for the benefit of first-year students, or those who, like doctors, dentists and others, require only a general elementary knowledge of this branch of chemistry. And it is his hope that it will prove useful for home study, particularly by those who wish to familiarize themselves with the more recent concepts of valence, the octet and duet in chemistry, north poles and south poles, dipole moments, resonance, dielectric constants, hydrogen bonding, parachors, Raman spectra, etc.

The first part of the book, therefore, is devoted to a general elementary study of atomic structure, interpreted in the light of modern up-to-date physical chemistry. The rest of the text deals with molecular structures and the organic chemist as the architect thereof. The various reactions encountered in studying the chemistry of these carbon compounds are explained largely by the application of the physical-chemical theories discussed in the antecedent pages.

In its unorthodox composition, the classification of compounds, sequence of topics, simplicity and origi-

nality of approach, it is quite the antithesis of the scissors-made text-book, and is both interesting and refreshing. Ingenious examples and similes are numerous. The "official" nomenclature for many classes of organic compounds is clearly explained. And yet the author throughout spells ole*fins* as ole*fines*, although in modern organic nomenclature the termination -ine is generally reserved for true bases.

The extent to which physical chemistry is used in the text, in addition to the 56 pages devoted to it in Part I as introductory, and the 20 pages on "From Partial Valence to Resonance" in Part II, will make its use for home study rather difficult reading for those who have not had at least an elementary course in that branch of chemistry. In other words, the book is essentially a primer of organic chemistry from the modern physical chemical standpoint. As such, it is cordially recommended, for it is clearly written and effectively presented. The net result, however, of so much physical chemistry, of rather frequent repetitions and of unnecessarily expanded structural formulas, has been to curtail seriously the amount of space available for the purely descriptive side of the subject, and that is just the side which is easiest and most attractive reading to the beginner.

The author's interest in etymology is indicated by the number of chemical words whose derivation and translation he gives. It is regrettable that so few of the great organic chemists of the past are mentioned by name in association with those parts of the science to which they have been the chief contributors. There are no references to the literature or lists of books suggested for collateral reading. In view of the author's position as senior chemist at the Edgewood Arsenal of the Chemical Warfare Service, U.S.A., it is somewhat surprising that the only war gas mentioned is "mustard gas." Phosgene, the chief killing gas of World War I, and still an important intermediate in several branches of chemical industry, does not appear at all. In the chapter on drugs, a number of the compounds mentioned bear only their German instead of their American names.

The arrangement of the subject-matter can be seen from the following table of contents: Part I. The Unique Position of the Carbon Atom in Chemistry, and a review of the modern theories concerning atoms, molecules, valence, etc. Part II—The Architecture of Carbon Compounds—discusses structural theories, chains and rings, double and triple bonds, stereochemistry and isomerism, from partial valence to resonance, paraffins, olefins, acetylenes and benzene hydrocarbons. Part III—The Classification of Carbon Compounds—presents the customary methods of classification, alkyl and aryl radicals, halogen compounds, primary, secondary and tertiary compounds, oxygen compounds (alcohols, phenols, ethers, aldehydes and ketones, acids and mixed types); nitrogen compounds; and compounds containing sulfur, phosphorus or other elements. Part IV—Special Topics in Organic Chemistry—is devoted to the structures of complex compounds, heterocycles and condensed cycles, the role of isoprene in nature, proteins, carbohydrates, dyes, drugs, hormones and vitamins, isotopic chemistry and giant molecules. A general index completes the book.

Paper, type and printing are exceptionally good. The proofreading is quite remarkable in its accuracy, not more than two or three slips having been found in the entire book. Illustrations, cuts, formulas, tabulations, etc., are admirable.

MARSTON TAYLOR BOGERT
COLUMBIA UNIVERSITY

SPECIAL ARTICLES

THE METABOLISM OF THE KIDNEY[1]

WITH a view to gaining an insight into the metabolism of the kidney in experimental renal hypertension a comparative study has been made of the concentration and activities of various enzyme systems in the kidney of normal and hypertensive dogs.

Experimental renal hypertension was produced in dogs by the clamping procedure of Goldblatt,[2] or by the Cellophane or silk perinephritis method of Page.[3] The tissue respiration was measured by the manometric method of Warburg.[4] The experiments were carried out with tissue slices, homogenized suspensions and tissue extracts at 37.5° C and at a pH of 7.4.

Histological examination of the portions of the kidney adjacent to the parts used in these experiments showed no necrosis.

I have studied the enzymatic activity of kidney slices and of homogenized tissue suspensions from the experimental and the opposite control kidneys of dogs with hypertension due to unilateral operations, from both kidneys of bilaterally operated hypertensive dogs and from the normal kidneys of non-hypertensive dogs. Preparations from the experimental kidneys of both types of hypertensive dogs, in comparison

[1] A detailed report of this work will appear in the *Journal of Experimental Medicine*.

[2] H. Goldblatt, J. Lynch, R. F. Hanzal and W. W. Summerville, *Jour. Exp. Med.*, 59: 347, 1934.

[3] I. H. Page, SCIENCE, 89: 273, 1939; *Jour. Am. Med. Ass.*, 113: 2046, 1939.

[4] O. Warburg, "The Metabolism of Tumours." New York: Richard R. Smith, Inc. 1931.

with normal kidneys and in comparison with the control kidney of the unilaterally operated dogs, showed a marked decrease in the concentration of cytochrome c and also a diminution in the activities of the cytochrome oxidase and succinic dehydrogenase systems. The rate of oxidation of pyruvate and of l(+)-glutamate as well as the rate of synthesis of carbohydrates from these substances was greatly decreased. The rate of formation of ammonia from the oxidative deamination of l(+)-glutamate was considerably reduced in these kidneys. The protein-bound phosphorus content was lower in the kidneys whose renal artery has been partially constricted or which were wrapped in Cellophane or silk.

When the renal artery of only one kidney was partially constricted or one kidney wrapped in Cellophane or silk, the control kidney, examined one to six months after operation, showed an increase in cytochrome c concentration, cytochrome oxidase, succinic dehydrogenase activities per gram of tissue of from 15 to 35 per cent. over and above the average of normal kidneys. Also after unilateral nephrectomy the concentration of cytochrome c, of flavin-adenine dinucleotide and of protein-bound phosphorus was about 20 to 40 per cent. higher in the remaining kidney.

Solutions of renin prepared according to the method of Helmer and Page[5] inhibited the activity of the cytochrome oxidase, the succinic dehydrogenase, the l-amino acid oxidase and the amine oxidase systems. The degree of inhibition ranged from 10 to 80 per cent., varying with the individual enzyme and with the amount of renin added. It must be noted, however, that pure renin has not yet been isolated and that the renin solutions used may contain other factors responsible for the inhibitory effect demonstrated.

Preparations of kidney tissue obtained from hypertensive dogs showed similar inhibitory effects. Heating at a 100° C for 5 minutes destroyed a great part of the inhibitory activity of these tissue preparations.

It has been reported that in experimental renal hypertension, the concentration of renin is increased in the kidney itself[6,7] and in its venous blood.[8,9]

Since renin is a proteolytic enzyme, it may, if it has access to the respiratory enzymes mentioned above, be responsible, directly or indirectly, for at least part of the decrease in the activities of the enzymes reported in this paper and in a previous study.[10]

The author gratefully acknowledges his indebtedness to Professor Charles H. Best for his interest in and support of this study.

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THE MILK AGENT IN SPONTANEOUS MAMMARY CARCINOMA[1,2]

PREVIOUS workers have shown that the milk agent for spontaneous mouse mammary carcinoma[3] is present in milk, in lactating mammary glands and in spontaneous or transplant tumor tissue, and that it can be at least partially sedimented or is associated with particles which are sedimented, in centrifugal fields of 20,000,[4] 60,000[5] and 110,000[6] times gravity.

In the experiments reported here spontaneous or transplant tumor tissue was used. The material was homogenized with distilled water, buffers or saline solution and then either was lyophilized or spun in a centrifuge and the supernatant treated in various ways.

The test animals were hybrids between C57 black mothers and A strain fathers or the back-cross mice from these hybrids to A males. In addition a few fostered C3H or A strain mice were used. The animals were between 4 and 10 weeks of age when they were injected with the various fractions mentioned below.

Results: One experiment, dealing with the stability of the milk agent toward heat, made use of the water extract of transplant tumor tissue. The supernatant was divided into 5 aliquot portions and these were kept at 4°, 37°, 60° or 90° C for 1 hour or at 24° C for 2 hours. All portions were brought to room temperature and an amount equivalent to 1 gram of original tissue was injected. The results are shown in Table 1. All animals in this experiment are now dead.

In another experiment frozen tumor tissue was extracted with saline solution and spun at 15,000 g for 30 minutes. Part of the supernatant was extracted with petroleum ether and gave rise to 5 tumors in 8 animals. The remainder of the supernatant was centrifuged at 50,000 g for 1 hour. The sediments at 15,000 and 50,000 g, the supernatant at 50,000 g and the Berkefeld N filtrate of the original saline extract gave rise to 1 or 2 tumors each out of 10 animals. An attempt to fractionate this same saline extract by

[1] From the Divisions of Physiological Chemistry and Cancer Biology of the Department of Physiology, University of Minnesota. Preliminary report.

[2] Aided by grants from the University of Minnesota Graduate School Funds and the Sivertsen Fund for Cancer Research and from the Jane Coffin Childs Memorial Fund for Medical Research.

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TABLE 1

Treatment	No. of mice	No. of tumors	Per cent. with tumors	Average tumor age, mo.	Average age of non-cancerous mice at death, mo.
4° 1 hour	18	9	50	16	18
24° 2 hours	17	6	35	15	18
37° 1 hour	19	4	21	16	19
60° 1 hour	18	0	0	..	20
90° 1 hour	18	0	0	..	20

$(NH_4)_2SO_4$ precipitation resulted in various fractions which gave rise to only 1 tumor out of 50 animals. This must be interpreted as meaning that the salt *per se* or the manipulations involved in the fractionation brought about an inactivation of the agent, or possibly that the petroleum ether removed some inhibitor.

Experiments in which phosphate buffer extracts of tumor material were incubated at room temperature at various pH values throw some light on the pH stability of the agent. Tumors have been noted from extracts kept at pH 5.0, 5.5, 6.3, 6.9, 8.7 and 10.2 for 1 or 2 hours. No tumors were noted after treatment at pH 4.5 for 2 hours, but such a negative finding will require confirmation. In general, the material soluble after incubation gave rise to more tumors than did the precipitates, even at pH 5.0, but these differences probably are not significant.

Another experiment which is not yet complete deals with acetone or petroleum ether extraction of lyophilized tumor material. So far 2 of 13 animals given ether-extracted material and 4 of 15 animals given acetone-extracted material have developed tumors. No tumors have developed from the acetone extracts, but in one group given an ether extract 2 of 10 animals have had tumors. This last material, however, differed from the other acetone and ether extracts in that it showed a granular precipitate as well as an oil when the solvent was removed.

Two recent experiments, both incomplete at the present time, deal with an attempt to precipitate the agent with the basic protein, salmine. The animals used in these experiments were all between 4 and 6 weeks of age. The starting material in both experiments was spontaneous tumor tissue, which in one case was used fresh and in the other was kept in the frozen state for several weeks. The tissue was extracted with saline or distilled water and the supernatants collected after centrifuging at about 2,000 g for 20 to 30 minutes. In one case the supernatant was adjusted to pH 5.5 and the soluble fraction treated with various concentrations of salmine. In the other case the original supernatant, which had a pH of 6.8, was treated with salmine. Tumors have already appeared from all fractions tested in both experiments with the exception of one of the sediments occurring after salmine treatment. The combined results of the two experiments are summarized in Table 2.

TABLE 2

Material	No. of mice	No. of tumors	Per cent. with tumors	No. still living	Average tumor age, mo.
Orig. S.N.	17	8	47	4	12
S.N. pH 5.5	10	4	40	2	13
Sed. pH 5.5	10	3	30	4	13
Salmine S.N.	38	17	45	11	12
Salmine Sed.	38	4	10	19	13

S.N. denotes supernatant; Sed. denotes sediment.

Perhaps the most important conclusion to be drawn from this experiment is that the one gram equivalent of tumor tissue, which all mice received, is much more than the minimal effective amount since tumors are developing from all fractions tested despite careful washing of all sediments. Experiments are now in progress to determine the minimal effective amount.

Summary: These experiments appear to show that the milk agent is destroyed at temperatures of 60° C and above, that it is stable at pH values between 5.0 and 10.2 but not at pH 4.5, that it is not inactivated by petroleum ether or acetone and not appreciably soluble in these solvents, and that it is partially, though perhaps only slightly, precipitated by salmine at pH values of 5.5 and 6.8.

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INHIBITION OF THE BACTERIOSTATIC ACTION OF MALACHITE GREEN BY ITS LEUCOBASES

THE bacteriostatic action of triphenylmethane dyes for Gram positive microorganisms is a well-known fact (see Churchman[1]). On the other hand, it is also generally acknowledged that the leucobases of these dyes are not bacteriostatic.

We carried out bacteriological assays with different leuco-derivatives of malachite green, such as leucobases, carbinol bases, bisulphite and hydrosulphite derivatives (leucosulphonic and leucosulphinic acids) and we found that:

(a) Carbinol bases, bisulphite and hydrosulphite derivatives possessed a bacteriostatic activity, no less, than the original malachite green dye (chloride or oxalate), *i.e.*, they were active until dilutions of 10^{-6} inclusively.

(b) The leucobases of malachite green had not only no bacteriostatic action in a dilution of 10^{-4}, but it

[1] Churchman, in Jordan-Falk's "The Newer Knowledge of Bacteriology and Immunology." Chicago. 1928.

was also able to diminish the action of malachite green and that of its active derivatives (Table 1).

TABLE 1

Dilution of the bacteriostatic substances:	10^{-5}	10^{-6}	10^{-7}
Malachite green alone	–	–	++
Malachite green + leucobase diluted 10^{-4}	–	++	++
Carbinol bases alone	–	–	++
Carbinol bases + leucobase diluted 10^{-4}	+	++	++
Malachite green bisulphite alone	–	–	++
Malachite green bisulphite + leucobase diluted 10^{-4}	–	++	++

– no growth; + weak growth; ++ regular growth.

These assays were carried out with a strain of scarlatinous streptococcus (Dochez) in peptone-glucose broth and in Goodman medium.

Such antagonism may be caused (a) by neutralizing the active compound directly through some chemical or physicochemical process (formation of new compounds or complexes, adsorption, etc.); (b) by opposite influences upon the milieu; (c) by some biochemical mechanism, as by inhibition of entering the toxic compound into the cell through competition or by opposite influences upon metabolistic processes, etc.

We are now investigating these possibilities and can already state that malachite green and its leucobase do not change oppositely the redox potential of the milieu (*cf.* Ingraham[2]).

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

RELATIVE POTENCY AS APPLIED TO THE ASSAY OF PENICILLIN

A SIMPLE estimation of the relative potency of penicillin, insulin[1] and other drugs can be made under conditions where the biological indicator gives a graded linear response when plotted against the logarithm of the dose. An unknown, U, is compared with a standard, S, at two concentration levels such that the dilution ratio $U_2 : U_1 = S_2 : S_1$. The two doses of the unknown are selected so that they will have the same potency as those of the standard, in so far as this can be determined in advance. The four doses are applied at random to sets of four quite similar biological units. The sets in turn are repeated until the potency of the unknown has been determined with the desired precision.

The data are given in Table 1 for a cylinder-plate assay of penicillin which meets these requirements. Four glass cylinders were placed on the inoculated agar of each petri dish. Two were filled with different doses of an unknown preparation (U_1, U_2) and two with corresponding doses of a standard (S_1, S_2). The diameter in millimeters of the cleared area about each cylinder on the following day is shown for each plate or set in the left side of the table.

In this experiment the calculations are shortened through the adoption of a ratio between concentrations such that $U_2 = 3.16\ U_1$ and $S_2 = 3.16\ S_1$, giving a log-ratio of $I = 0.500$. This modification was first proposed by Dr. Lloyd C. Miller, to whom I am indebted for the data in Table 1, and it has been used successfully for penicillin assays at the Winthrop Chemical Company, Inc.[2] Both U_2 and S_2 are prepared initially to contain 2.0 U/cc of penicillin, the unknown in the present case having an assumed potency of 400 U/mg. The weaker dilutions are obtained by adding 2.31 cc of S_2 and U_2 to vessels containing 5.00 cc of buffer solution.

The first step in the analysis is to compute four differences for each plate, as shown in the second part of Table 1. The successive differences are those of the unknown minus the standard at the high (D_1) and at the low (D_2) dosage levels and of the high minus the low dose for the unknown (D_3) and for standard (D_4). These initial differences are then used to obtain the basic computing units (y). The values for $y_1 = D_1 + D_2$ total the effect of the differences between the two preparations, while those for $y_2 = D_3 + D_4$ total the effect of the differences between the two dosage levels. The differences $y_3 = D_1 - D_2 = D_3 - D_4$

TABLE 1

Plate No.	Diameter in mm for U_2	U_1	S_2	S_1	$D_1 = U_2 - S_2$	$D_2 = U_1 - S_1$	$D_3 = U_2 - U_1$	$D_4 = S_2 - S_1$	$y_1 = D_1 + D_2$	$y_2 = D_3 + D_4$	$y_3 = D_1 - D_2 = D_3 - D_4$
1	25.8	20.8	25.6	20.4	.2	.4	5.0	5.2	.6	10.2	–.2
2	25.8	21.0	25.2	20.4	.6	.6	4.8	4.8	1.2	9.6	0
3	25.4	20.4	24.8	20.0	.6	.4	5.0	4.8	1.0	9.8	.2
4	25.8	20.8	25.2	20.4	.6	.4	5.0	4.8	1.0	9.8	.2
									3.8 = T_1	39.4 = T_2	.2 = T_3

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[2] L. C. Miller, J. H. Bailey and W. F. Warner (in preparation).

test whether the dosage-response curves for standard and unknown are parallel. Computing y_3 in two ways checks the correctness of the original differences. The computing units are then summed for each column to obtain T_1, T_2 and T_3, respectively.

The potency of the unknown is computed in logarithmic units. If the unknown is assumed to have the same potency as the standard, values such as those in the right hand and lower portion of Table 1 lead directly to the logarithm of relative potency, M′, by the formula

$$M' = \frac{IT_1}{T_2} = \frac{0.5 \times 3.8}{39.4} = 0.0482 \qquad (1)$$

where I is the dosage interval in logarithms and the numerical values are those obtained from Table 1. To express the results in Oxford units, the unitage assumed in carrying out the assay is used. The estimated log-potency (M) is given by the equation

$$M = \log \text{ (assumed unitage or potency)} + M' = 2.6021 + 0.0482 = 2.6503. \qquad (2)$$

From the antilog of M the potency of the unknown has been assayed at 447.0 U/mg.

The above calculation differs from a similar proposal[3] in leading directly to an easy estimate of the standard error, s_M. While some factors in the determination of potency are not tested in a single assay—and these may be of first importance—the precision of a given technique is no greater than that indicated by the standard error. The latter depends upon several intermediate terms. The first of these, the slope of the dosage-response curve, is computed as

$$b = \frac{T_2}{2IN}, \qquad (3)$$

where N is the number of sets or plates in the assay. With $I = 0.500$, this may be simplified to

$$b = \frac{T_2}{N} = \frac{39.4}{4} = 9.85. \qquad (3a)$$

The standard deviation of a single response as computed from all relevant data is

$$s = \sqrt{\frac{S(y^2) - (T_1^2 + T_2^2 + T_3^2)/N}{12(N-1)}} = \sqrt{\frac{392.20 - 391.71}{36}} = 0.1167, \qquad (4)$$

where y refers to all individual values of y_1, y_2 and y_3 and $S(y^2)$ is the sum of their squares. The standard deviation in the response is divided by the slope to transform it from units of response (y) to units of log-dose (x), giving

$$\lambda = \frac{s}{b} = \frac{0.1167}{9.85} = 0.01185. \qquad (5)$$

The smaller the term λ the more sensitive is the assay for detecting differences in potency. The standard error of M or of M' is then equal to

$$s_M = \lambda \sqrt{\frac{1}{N}\left\{1 + \frac{T_1^2}{T_2^2}\right\}} = 0.01185 \sqrt{\frac{1.0093}{4}} = 0.0060. \qquad (6)$$

To realize the full precision of a given method, the assumed potency should not differ widely from the true value. Changes in technique which increase the inherent precision of an assay will reduce λ. With a standardized procedure, λ should be relatively stable from one assay to another.

Most tests of statistical significance are made in units of $M \pm s_M$. In original units an average standard error may be computed as

$$\text{standard error of potency} = 2.30 s_M \text{ (antilog M)}. \qquad (7)$$

In the present case the potency of the unknown would be reported as 447.0 ± 6.2 U/mg. This agreed well with a parallel assay of the same preparation, which gave a potency of 451.7 ± 5.6 U/mg.

The above procedure assumes that the dosage-response curves for standard and unknown are parallel. This assumption may be tested by the t-test for the significance of a difference where

$$t = \frac{T_3}{2s\sqrt{N}} = \frac{0.2}{2 \times 0.1167 \times 2} = 0.43 \qquad (8)$$

The observed value is referred to a suitable table[4] with $3(N-1)$ degrees of freedom and should not exceed the value for $P = 0.05$. In the present case no divergence from parallelism is indicated. The above design for an individual assay holds equally for those repeated frequently in the same laboratory, but in the latter case a modified calculation may be preferred.[5,6]

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SCIENCE NEWS

Science Service, Washington, D. C.

FEDERAL AID TO RESEARCH ON CANCER

A PLAN for Federal aid to cancer research, with an initial appropriation of $2,000,000, was presented recently by Dr. E. V. Cowdry, of Washington University and the Barnard Free Skin and Cancer Hospital, St. Louis, to the Senate Subcommittee on Health and Education.

The plan for Federally aided cancer research might serve as a pilot plan for future Federal aid to medical research, Dr. Cowdry told the subcommittee which, under the chairmanship of Senator Claude Pepper of Florida, is conducting hearings on the subject.

He pointed out that cancer is the most dreaded of all diseases. Heart, artery and kidney diseases are greater killers but more merciful. The $2,000,000 appropriation should, Dr. Cowdry believes, be made to the National Cancer Institute, a Federal agency which already leads in cancer research. This institute would disburse the money to institutions of recognized ability to conduct both short- and long-term research on cancer.

The provisions of Dr. Cowdry's plan indicate that the institutions receiving the money would be free to accept funds also from private sources. The additional Federal aid, he believes, would increase the value accruing from the private funds for cancer research.

An unusual feature of the plan is the suggestion that Congress should authorize the issue of a special series of government bonds to be nontransferable and bear 5 per cent. interest. These could be purchased only by privately managed, non-profit colleges and universities. In this way the less well-endowed institutions could get Federal aid without giving up their individual freedom.

The amazing speed with which such spectacular health aids as penicillin, DDT and blood substitutes, including plasma, were developed by Federally sponsored and aided research during the war was cited as evidence of what Federal aid to medical research can accomplish.

"In the postwar period, research can be neglected only at our own risk," Brigadier General James S. Simmons, chief of the preventive medicine section of the Office of the Surgeon General, told the subcommittee. "This nation affords unlimited natural resources in scientific talent which need only opportunity and facilities to bring them to bear upon the health problems of the nation in peace or in war. It is gratifying to see the interest of this subcommittee in making provision for the continuation of essential research activities in the postwar period."

Dr. Lewis H. Weed, chairman of the division of medical sciences, National Research Council, pointed out that Federal aid to medical research should be planned with regard to the total medical problem, which includes medical practice, hospitals and preventive medicine and public health.

ITEMS

THIRTEEN boy scientists in India are conducting Americans in the Armed Forces on hiking and hunting trips. Seven Americans are included among the students of the Woodstock School at Mussoorie, United Provinces, India, who make up the group. The boys range in age from 13 to 17. They are members of the first science club in India to affiliate with the Science Clubs of America, the organization for the promotion of scientific activities for school-age boys and girls, which has 125,000 members in 5,000 clubs in this country. For five months the club has been making displays of native mammals, reptiles, insects and plants under the direction of Robert L. Fleming, biology instructor. Now they have opened their headquarters to visiting service men and take these men on field trips to see the animals and plants in their native habitat.

VITAMIN C can be obtained by a new process developed at the National Bureau of Standards by Horace S. Isbell and Harriet L. Frush, who have found that an important source of the vitamin, galacturonic acid in the form of a salt, can be separated from solutions containing substantial amounts of impurities. Thus, a source of the acid is made available for the synthesis of the vitamin. In the process, beet pulp was hydrolyzed by a commercial pectic enzyme, after which the resulting galacturonic acid was separated from the residue in the form of a salt. It was found that the double salt, sodium strontium galacturonate, crystallizes from the hydrolyzates of beet pulp in the highest yield, but two other salts are of value in separating galacturonic acid from the hydrolyzates of pectic substances. The commercial use of beet pulp for the preparation of galacturonic acid presupposes a cheap source of pectic enzyme. Since these are produced in the growth of numerous molds, and occur in the culture media, they might be obtained economically as by-products in certain industries. Possible sources, the bureau states, are the aqueous solution remaining after the separation of penicillin, or the culture media of molds grown for food purposes.

A METHOD for producing "synthetic blood plasma" from a by-product of sugar manufacture has been developed by two Swedish investigators, Anders Groenwall and Bjoern Ingelman, working under the supervision of Professor Arne Tiselius, of the University of Uppsala, according to information received in New York City by the American Swedish News Exchange. Dextran is the name given the material. Unlimited production of it is said to be possible. It can be easily transported as a powder, is reasonable in price and its use is not dependent on the blood group of the recipient. Dextran has not yet come to the attention of medical authorities at Washington but a number of preparations, such as pectin and gelatin, have been tried as substitutes for blood plasma in the treatment of shock. One that the Germans developed has been investigated by authorities, but has not proved very effective. Blood plasma and serum albumen from human blood have not yet, however, been equalled as shock-combating substances by any of the substitutes so far investigated except, perhaps, under special circumstances.

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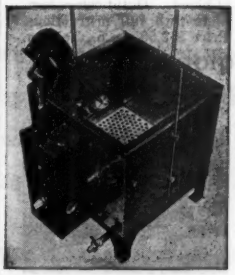

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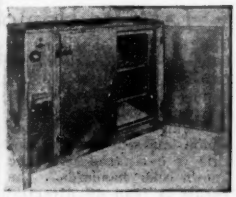

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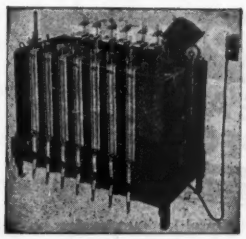

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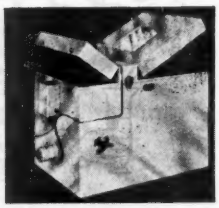

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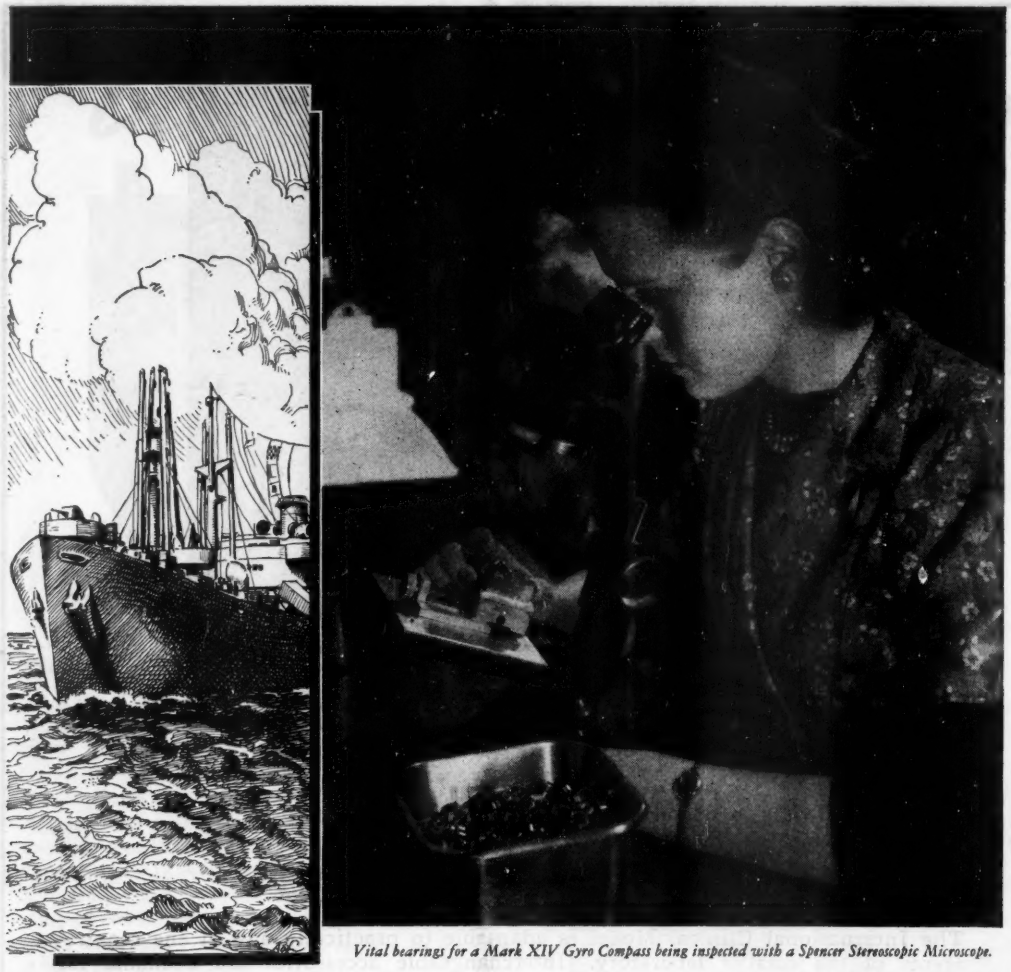

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